Issues in Engineering

JANUARY 1981

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DISCUSSION

Proc. Paper 15951

*Discussion period closed for this paper. Any other discussion received during this discussion period will be published in subsequent Journals.

15967 ASCE ROLE ON CONTROVERSIAL ISSUES

KEY WORDS: ASCE (Aims and Activities); **ASCE (Policy);** Policies; **Public policy**

ABSTRACT: The role ASCE takes in influencing public policy on controversial technical issues should be an active one. When the issue at hand is the safety of a nuclear power plant or some other question involving the use of technology, ASCE should not just be silent, but should be involved in informing the public on the controversies at hand. Professional organizations such as ASCE have a duty to aid in the formulation, presentation, and solution of these problems. The formulation and presentation of recommendations to the public is the role ASCE has in influencing public policy. Further involvment in the process can be realized by communicating with legistative bodies, agencies of government, and others influential in the determination of public policy.

REFERENCE: Zediak, Stephen P., "The Role of ASCE in Influencing Public Policy on Controversial Issues," *Issues in Engineering—Journal of Professional Activities,* ASCE, Vol. 107, No. EI1, **Proc. Paper 15967,** January, 1981, pp. 1-2

15969 STUDY GROUPS: LOW COST CONTINUING EDUCATION

KEY WORDS: **ASCE (Education); ASCE (Members);** Colleges; **Continuing education; Costs; Engineering education;** Plans; Specifications; **Theorems**

ABSTRACT: Formal civil engineering study groups sponsored by the ASCE can be a cost effective way to disseminate the latest engineering information. Small study groups within each ASCE region could present detailed solutions to problems tempered by local conditions, climate, codes, prices, and tradition. Cost would be minimized since this is a cooperative, evening program, drawing speakers from within its own ranks, or course materials from ASCE correspondence courses. This would eliminate additional expense incurred when attending national or regional conferences.

REFERENCE: Haimowitz, Jerry, "Study Groups: Low Cost Continuing Education," *Issues in Engineering—Journal of Professional Activities,* ASCE, Vol. 107, No. EI1, **Proc. Paper 15969,** January, 1981, pp. 3-5

15972 APPROPRIATE TECHNOLOGY: A MODEST PROPOSAL

KEY WORDS: Developing countries; Education; **Engineering education; Engineering evaluation; Foreign engineering;** Periodicals; **Problem solving;** Social impact; **Technology**

ABSTRACT: Appropriate technology implies subjective suitability evaluation of technical solutions to social requirements. Informed and critical evaluation is necessary if technology is to respond adequately to changing social needs. The training of engineers is largely directed toward physical, not social, descriptions of problems. It is proposed that an exposure to engineering applications in developing nations be included in North American engineering professional development. This exposure should not be at the expense of proper theoretical analysis. This exposure will impart some implicit understanding of engineering's common role but diverse contribution in alternative social settings. Engineers aware of and interested in technical solutions appropriate to other cultures will be better prepared to innovate engineering practice in accord with social development in their own society. Engineers aware of social-technical solutions to other cultures will be better equipped to lend their services to those societies.

REFERENCE: Heggen, Richard J., "Appropriate Technology: A Modest Proposal," *Issues in Engineering—Journal of Professional Activities,* ASCE, Vol. 107, No. EI1, **Proc. Paper 15972,** January, 1981, pp. 7-10

15988 TO JOINT VENTURE, OR NOT - IS IT FOR YOUR FIRM?

KEY WORDS: **Administration;** Efficiency; Fees; **Financing; Joint operations; Management systems;** Market research; **Mergers;** Profits; Requirements; **Responsibilities**

ABSTRACT: The paper provides a "how to do it management system" for small firms interested in joint venturing. The writer relates various experiences and points out practical problems to eliminate guesswork, avoid pitfalls, and reduce costly trial and error methods.

REFERENCE: Black, Duncan M., "To Joint Venture, or not—Is it for Your Firm?," *Issues in Engineering—Journal of Professional Activities,* ASCE, Vol. 107, No. EI1, **Proc. Paper 15988,** January, 1981, pp. 11-23

15989 MANAGING JOINT VENTURES IN PUBLIC PROJECTS

KEY WORDS: **Construction management;** Consultants; Design; **Management; Mergers; Organizations;** Project management; **Transportation**

ABSTRACT: The history and current organization of the joint venture—serving serving as the general engineering consultant to the Metropolitan Atlanta Rapid Transit Authority—are are briefly reviewed. Design and construction management on this large project are summarized. Selected aspects of cost and schedule control, equal employment opportunity programs, and wrap-up insurance are also presented.

REFERENCE: Lammie, James L., and Shah, D. P., "Managing Joint Ventures in Large Public Projects," *Issues in Engineering—Journal of Professional Activities,* ASCE, Vol. 107, No. EI1, **Proc. Paper 15989,** January, 1981, pp. 25-39

15990 MANAGING PUBLIC SUPERPROJECTS: THE TEAM APPROACH

KEY WORDS: **Benefits; Construction management; Consultants;** Cost effectiveness; **Management;** Municipal engineering; Planning; Programs; **Projects; Systems management**

ABSTRACT: The program management approach of managing public sector superprojects is defined, analyzed and evaluated. The writers draw on their own experience to explain the benefits and drawbacks of implementing program management techniques. Program efficiency, contractor accountability and public agency consultant relations are given special emphasis. Public agency and consultant responsibilities are outlined, and specific communications channels are suggested for strengthening the agency consultant bond. Program and project analyses, and their importance in cooperative agency consultant planning, are discussed. Configuration management is explained, and its role as a planning control tool is emphasized. Commom problems associated with program management are analyzed; suggestions are given on how to avoid them.

REFERENCE: Wesselman, Joel, Katz, William J., and Gibbs, Charles V., "Managing Public Superprojects: The Team Approach," *Issues in Engineering—Journal of Professional Activities,* ASCE, Vol. 107, No. EI1, **Proc. Paper 15990,** January, 1981, pp. 41-50

15991 BOSTON'S SOUTHWEST CORRIDOR PROJECT

KEY WORDS: **Consultants;** Cooperation; Designers; Management; **Rapid transit systems;** Transportation; **Urban planning**

ABSTRACT: Drawing on experiences with the Massachusetts Bay Transportation Authority (MBTA) Southwest Corridor Project in Boston, mass., the initial through final stages of organizing a design team are illustrated as Boston's Southwest Corridor is transformed from a proposed highway to a mass transit/commuter rail facility. The design team is faced with not only a challenging engineering task but also a very demanding political issue. Intense community participation and related social issues are reflected in working relationships and processes. The role of the MBTA affects the organizational structure. The scope of the work is defined as the engineering agreement and subconsultant agreements are negotiated. Estimates are prepared on costs and man hours. Organization for the project is also a prime concern. The Management Information System is also explained as an important aspect of the project's successful completion.

REFERENCE: Hall, Francis X., and Shumway, Lawrence W., "Boston's Southwest Corridor Project," *Issues in Engineering—Journal of Professional Activities,* ASCE, Vol. 107, No. EI1, **Proc. Paper 15991,** January, 1981, pp. 51-59

15997 TEACH GEOLOGY TO CIVIL ENGINEER STUDENT

KEY WORDS: **Engineering education; Geology;** Geotechnical engineering; Professional practice

ABSTRACT: Geology is not a familiar discipline to many practicing civil engineers. Most American universities do not require a course in practical or applied geology for the civil engineer student. A program involving professionals from industry lecturing on their specialty should be encouraged to allow students to learn firsthand about current, practical problems.

REFERENCE: Proctor, Richard J., "Let's Teach Geology to the Civil Engineer Student," *Issues in Engineering—Journal of Professional Activities,* ASCE, Vol. 107, No. EI1, **Proc. Paper 15997,** January, 1981, pp. 61-63

15995 REPORTING AN EMPLOYER'S UNETHICAL ACTIONS

KEY WORDS: Education; Employment; **Ethics;** Public health; **Responsibility;** Safety

ABSTRACT: An engineer's responsibility to the public and his employer is viewed from the perspective of the ASCE Code of Ethics. The psychological theories of Dr. Maslow are used in discussing factors which complicate the application of the doctrines set forth in the Code of Ethics.

REFERENCE: McCrate, Thomas A., "Reporting An Employer's Unethical Actions: Should We? Do We? Will We?," *Issues in Engineering—Journal of Professional Activities,* ASCE, Vol. 107, No. EI1, **Proc. Paper 15995,** January, 1981, pp. 65-66

The Role of ASCE in Influencing Public Policy on Controversial Technical Issues[a]

By Stephen P. Zediak[1]

The role the ASCE takes in influencing public policy on controversial technical issues is a very important one. The method by which these issues are settled is of major concern to the ASCE, as well as the general public. The role of the ASCE should be an active one. Clearly, the ASCE should not just be silent on these technical issues, but should be involved in informing the public of the controversies at hand.

Lincoln said in 1861, "the people would rule themselves; they would decide vital questions of national policy." This is true today, for we still have questions facing the public with regard to public policy. We are living in an age in which the quality of life is largely dependent on technology. This technology affects us physically, socially, and politically. The American public has come to insist on having a say in how this technology is to be utilized and where or whether engineering works should be built.

Items such as the safety of nuclear power plants, building structures in earthquake zones, and other questions involving technology are currently being looked at closely. We have reached the point where we are more concerned with the consequences of our actions now than we have been in the past, particularly concerning resource usage. We not only consider the feasible, efficient, economic operation of a system, but also the effect on the environment. More and more, policy makers are now beginning to look at past methods, practices, and technology to aid in reaching a final decision on a specific matter, whether it is controversial or not. The efforts of the scientific, technological, and political arenas of society must all be combined if the needs and goals of society are to be met. Establishing the means and managing the resources for the benefit of all, without degrading the social and physical environment is the role of the public policy maker. Whether the policy maker is a person,

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group, or government, the policy maker cannot impose politically or socially unacceptable changes on society. Many times, government officials who are instrumental in deciding policy, lack the knowledge to identify or evaluate innovative solutions. Professional organizations, such as the ASCE, have a duty to aid in the formulation and solution of these problems.

The development of public policy involves three activities: (1) Goal setting; (2) allocation of resources; and (3) evaluation of effectiveness. Goal setting is simply identifying the needs of society, and setting priorities among these needs. Allocation of resources must be made for these goals to be realized. An evaluation of alternatives is important in the process, for it provides a way for policy goals to be met if the original assumptions breakdown. The evaluation of effectiveness is crucial, for it gages the potential advantages or disadvantages a certain decision may have on society. The three steps for development of public policy all require specialized knowledge, technical skill, and methods of analysis to evaluate all the means of attaining a policy goal.

Throughout the whole process, there must be an opportunity for involvement and contribution from citizens, special interest groups, and others that may have input. The ASCE is in a position to evaluate these means. The members of the organization have the knowledge and expertise to make recommendations in this process. The formulation and presentation of these recommendations to the public is the role the ASCE has in influencing public policy.

The formulation of these facts involves researching the situation at hand. A case or record cannot be made when the facts are not present. Therefore, it is imperative that the ASCE present the necessary facts accurately, when making a proposal. Also, having a firm conviction that the proposal is logical, is essential for convincing another party that it is reasonable.

The problem of educating the citizenry and its elected officials to understand the potentialities and limitations of scientific-technological advances is of prime concern today, for it is the citizens who decide what the policy shall be. At a local level, the ASCE can become involved by the creation of local committees oriented toward providing technological information to the public concerning these controversial issues. Information packets can also be distributed to various local, civic, educational, or religious organizations whenever appropriate. Analysis, at local and state levels, of a certain proposal, should be held openly and frankly for a concensus of the majority to be reached. Notification of the position to be examined at an open section meeting could be made in section newsletters, newspapers, and other media. Input from local citizens and groups could be made at these open meetings.

The ASCE can further become involved in the public policy process by communicating with legislative bodies, agencies of government, and others influential in the determination of public policy. A joint effect can be realized by the ASCE membership by encouraging other technical societies of science and engineering to organize and take a position.

At the national level, use of the media can further reinforce the reasons, advantages, or disadvantages of a policy statement proposal. This active role that the ASCE should take can be followed through to the end by support of bills being presented through the congressional process. *E Pluribus Unim*: Out of Many Comes One, is the philosophy that the ASCE as an organization should use to formulate the final policy statement that is presented to the citizens.

STUDY GROUPS: LOW COST CONTINUING EDUCATION

By Jerry Haimowitz,[1] M. ASCE

INTRODUCTION

Locally-formed study groups can provide a low cost vehicle for continuing education in engineering design skills oriented to local conditions. The following material will demonstrate that civil engineers can benefit from such study groups and will show how they can be organized. First, the importance of continuing education will be briefly demonstrated and the existing system of national and regional short courses will be briefly studied. This review of the existing system will show that there is a need not now filled, for an educational system which can teach the preparation of finished plans and specifications tempered by local conditions, codes, climate, prices, and traditions. This need can be filled by locally-formed study groups. This paper will present two different study group systems currently in use by the medical profession, which civil engineers could adapt for their own use.

CONTINUING EDUCATION

Engineers often desire to continue their education after college. They are usually seeking the practical background required to prepare plans and specifications, rather than the generalized theoretical knowledge that forms a large part of college training. The generalized background provided in college is the foundation upon which practical knowledge is built. It must be broad and sound, leaving little time for practical design problems. Even a 5-yr program only allows a very limited and often generalized grounding in practical matters. Moreover, problems in practice cover a wide range, and are affected by local conditions, codes, climate, prices, and traditions. This makes it difficult for a school in Maine, e.g., to train engineers for California.

Mostly, continuing education is provided by formal short courses, sponsored by universities, government agencies, and professional societies. However, these

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formal short courses have two limitations. The first problem is cost. The last 10 invitations to attend short courses received by this writer indicated registration fees of $95–$550; the average cost was $250. The ASCE sponsors short courses which cost $125–$325 (3). The duration of the courses is from 1–3 days. To the registration cost must be added the cost of plane fare, room and board, the time lost traveling, and the time spent in the classroom instead of the office. The second limitation is the natural or regional appeal built into most of these courses. To retain this broad geographic appeal, a certain degree of generality is required. Such courses usually cannot address local conditions, climate, codes, prices, or traditions.

Locally-organized study groups could offer programs oriented towards solutions to practical problems tempered with local conditions. They could be a vehicle by which each engineer could learn to solve new problems, and learn new solutions to old problems without muddling through that first real project, losing money, displeasing the client, and exposing himself to liability. Study groups can be an inexpensive evening program, meeting one to four nights a month to fit the economic reality and social schedule of the average engineer. Such groups already exist in the medical profession (2).

Proposed Study Group

There are two possible membership formats for a study group. One format would be for the group to be formed by the local ASCE chapter, but open to all engineers. As a practical matter, sessions would be formally advertised only within a 1h–2h radius of the meeting point. The other format would be to have a limited, fixed membership. The Somerset Valley Study Club for dentists has a limited membership of 20 but requires each member to attend at least six monthly meetings per year to maintain membership (2).

The membership format would influence the topics chosen for review. There are many aspects to civil engineering. With a fixed membership and required attendance, a group would have difficulty crossing specialty lines. For example, structural engineers would not have enough common interest with sanitary engineers to be in the same group. The limited, fixed membership is most suited to a specialty group. Also, a limited membership group would be an excellent vehicle for individuals to attain the maximum benefit from an ASCE correspondence course. The members would be able to learn from each other, as well as from the course.

An open group could sponsor one to four meetings a month on varied topics. Since any engineer could attend, the meetings would probably be well attended. This could also be a vehicle for the ASCE to attract new members by demonstrating its ability to respond to the needs of engineers. One meeting per month might deal with a topic of interest to all engineers, such as estate planning. The other three could be narrow, specialty sessions.

A closed group would have a fixed mailing list that would facilitate easy communications. An open group would have a more difficult advertising problem. A simple way to contact the most potential participants would be to mail a notice to every engineering firm in the area and advertise in the local ASCE section or branch newsletter.

The goal of the group would be to learn to solve practical problems and

to translate the solutions into finished plans and specifications. The meeting could be controlled by a moderator or the speaker. The speaker could be an expert brought in from outside the group or a group member. The speaker would research a topic and make a presentation which would be followed by a group analysis. To reduce cost, outside speakers should be avoided as much as possible.

A study group similar to the aforementioned would not be very expensive. However, there may be expenses for occasional speakers, meeting facilities, refreshments, or advertisements. In a fixed membership group, a yearly dues could be levied. With open membership, an admission fee of up to $5 might be required.

Conclusion

The study group is a continuing education technique with great potential that is already used by the medical profession. It could be introduced to civil engineering by utilizing the existing ASCE infrastructure and sponsorship. Study groups can be vehicles for maximizing the benefit from ASCE correspondence courses; they can efficiently disseminate the details of practical, cost effective, locally-oriented design, and can provide continuing education with less time and expense than national and regional seminars. The ASCE should consider investigating the formation of study groups to provide cost effective, practical, design-oriented, continuing education.

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to translate the solutions into finished plans and specifications. The program could be controlled by a moderator or the speaker. The speaker could be an expert brought in from outside the group or a group member. The speaker would research a topic and make a presentation which would be followed by a group analysis. To reduce cost, outside speakers should be avoided as much as possible.

A study group similar to the one developed would not be very expensive. However, there may be expenses for occasional speakers, meeting facilities, refreshments, or advertisements. In a fixed membership group, a membership [illegible] could be levied. With open membership, an admission fee of [illegible] could be required.

Conclusion

The study group is a continuing education technique with great potential. It is already used by the medical profession. It could be introduced in civil engineering by utilizing the existing ASCE organizations and relationships. Study groups can be vehicles for assimilating the benefit from ASCE [illegible]; they can effectively disseminate the details of practical, cost-effective, locally-oriented design, and can provide continuing education with less cost and expense than national and regional seminars. The ASCE should consider investigating the formation of study groups to provide cost-effective, design-oriented, continuing education.

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APPROPRIATE TECHNOLOGY: A MODEST PROPOSAL

By Richard J. Heggen,[1] A. M. ASCE

INTRODUCTION

Appropriate technology (AT), is by definition an applied scientific means of problem solving deemed to be best suited to a specific society. Who could knowledgeably tout anything else? The ASCE "People Serving" emphasis is a commitment to AT. By the subjective phrase, "deemed to be best suited," however, AT is in a nebulous arena. Rules for determining "appropriateness" vary with disciplines. By our training as engineers, we traditionally gage appropriateness by quantifiable criteria: calories, man-hours, tons, dollars. Others may judge appropriateness on the basis of tradition or belief. Many technological conflicts of today (alternative energy sources, safety, environmental-economic tradeoffs) are, in fact, debates of appropriateness. It is on the identification of appropriatness that we in engineering must increasingly focus.

An engineer's understanding of AT may be made more articulate by courses in sociology, economics, or art, but it is entirely possible to academically master such subjects without adequately addressing their relevance to engineering. A engineer's comprehension of AT is more likely to result from personal observation and reflection.

An engineer who initiates problem solving by consciously identifying the often complex social needs and constraints is more likely to proceed to an appropriate solution than an engineer who initiates the process by describing a machine. This is not to say that we should allow sound technology to be subservient to fuzzy social understanding, but that we should direct our efforts toward both improving that understanding, and using the best of that understanding for direction.

PROPOSAL

A cost-effective gain in the understanding of AT might come from adding an emphasis to both our professional journals and training. This emphasis should

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satisfy three objectives: (1) Engineers would gain an appreciation of technical objectives other than those traditionally sought in their own society; (2) engineers would observe and evaluate solutions toward those objectives in a sound theoretical manner; and (3) engineers would implicitly gain awareness of AT in their own society.

It is proposed that engineering education, both classroom and continuing, gives emphasis to problems experienced in other cultures appropriately solved by technologies alternative to North American practice. Although AT should not be confused with one subset, "intermediate" or "small-scale" technology, the latter provide data and illustrations of instructional value. Engineering problems having a similar theoretical basis but alternative technical solution, each suited to a particular social setting, teach appropriateness. We may have as much to learn from appropriate engineering solutions in developing nations as those nations have to learn from AT here.

Developing Nations

AT has two engineering facets: appropriate analysis and appropriate application. The first aspect refers to planning and design, the engineering paperwork. The second, readily envisioned, refers to the employment of men and materials and the final technical product, the fieldwork. It is often the case in developing nations that appropriate applications, in part, resemble applications of past years in developed nations. Use of such applications may be desirable for several reasons. Tested methods are generally reliable; a developing nation need not invest resources in trial-and-error solutions. A technical method outdated in a developed nation may well have contributed to the process of that development. Unfortunately, however, the focus on the application aspect of AT and the associaction of these applications with unsophisticated and small-scale engineering methods may lead the hasty observer to conclude that AT is just a new name for dated engineering practice.

It is in the realm of engineering analysis that AT for developing nations should not lag behind planning and design techniques in more developed nations. Indeed, the advent of systems analysis and the world wide availability of microcomputers should facilitate in developing nations the employment of technical applications superior in design to similar, but older applications in the United States.

Not only will an improved understanding of AT help us better respond to evolving North American social objectives, it will help us better assist technology, especially the analytic portion, in other nations. In the long run, there are more Cameroons in need of our aid than Saudi Arabias. It is in our own national interests that we field an engineering profession broadly aware of world, not just Western, development.

Three Examples

Several examples indicate the possibilities of incorporating AT into our educational process:

1. Engineering statics and structural analysis regularly resort to bridge trusses to illustrate basic concepts. The illustrations are clear. But might not some

illustrations or practice problems dealing with the multistory bamboo scaffolding used today in China teach the same theory? The student would become somewhat more aware of the potential of that natural material and social development in that nation. The student's ability to balance forces would not be reduced.

2. Engineering economics is decision theory for optimal management of tangible resources. Efficiency and engineering are akin terms. But efficiency is strictly measured in monetary effectiveness and optimality is measured in monetary return in only a portion of the world. The economic description of public works in an African village might illustrate assumptions and values minimally considered in classical benefit-cost analysis. The illustration might have practical worth; American Economic emphasis may someday change from growth and profit maximization to maintenance and necessary resource redistribution. Engineers will be the professionals who smooth the transition.

3. Systems analysis is employed to optimize water resource development, typically the employment of multipurpose reservoirs. But many water resource problems are appropriately solved by alternatives to centralized construction. Household water supply by rainwater catchment leads itself to systems theory as well as does the big dam. Proper design of rainfall catchment systems, the determination of catchment area and reservoir capacity appropriate for precipitation pattern, water demand, and benefits of satisfying that demand, may be achieved by mathematical simulation. Alternative designs of catchment systems are tested against an historical or synthetic record of rainfall. The catchment design which yields the fewest periods of deficit in water supply for a given investment in materials, or alternatively, satisfies demand at a given level for the least investment, is an efficient design. The balance of inputs (labor and materials) to efficiently achieve an output (reliable water supply) may be determined by isoquant analysis. The engineering problem is similar in form to reservoir operation by a linear rule. There are only a limited number of dams left to be constructed. There are an unlimited number of technical alternatives to be evaluated.

To the aforementioned examples, a reaction might reasonably be, "The engineer who knows the tools will discover their appropriate uses." Were the basics taught without constant references to advanced technology, this should be so. If however, the engineer is not led to segregate modern technology (i.e., what seems to be appropriate to this nation today) from basic theory, then the two intertwine in the cognitive process. Thumb through any journal or text to discover the tilt. Again, it is not proposed to slight new development and technically complex solutions, but rather to bring to light the relation between setting and solution.

It should be noted that AT is becoming a recognized field, as evidenced by such journals as *Appropriate Technology* (1), *Approtech* (2), and *VITA News* (5). These periodicals illuminate the type of problems encountered, and solutions evolved throughout the developing world. It seems somewhat unfortunate that these journals need even exist, interspersing reports on cable bridges with reports on vegetable protein texturizers. If bamboo makes good waterpipe (it often does), that information should be visible in established engineering literature, not in dated United States Department of Agriculture publications. Engineering professionals should be at the forefront of this field, not leaving it to the

well-intentioned but often marginally-equipped field workers.

The National Science Foundation has initiated an AT program (4). Congress is developing a technology-transfer program. The World Bank, the Agency for International Development, the World Health Organization, the National Academy of Sciences, and most domestic Federal agencies support AT. Hundreds of private groups sponsor AT development (3). AT is gaining sanction, funding, and (hopefully) informed direction.

Conclusion

The costs of this proposal are small. Engineering tests are regularly revised in any manner. There are enough foreign-born and American faculty with cross-cultural experience to acquaint students with novel illustrations of both objectives and solutions. Technical journals need not sacrifice quality; they need only to recognize meritous work in a larger world. Professional societies need to lend their prestigious support to third-world concerns. There is some movement in this direction already.

The benefits of this proposal may be large. AT provides a model of not simply how to do a job correctly, but how to improve upon the solution. Exposure to alternative technologies will not generate a regressed class of engineers, but rather one better equipped to evaluate technology's prevailing direction and constraints. As we become aware of the variation of objectives between societies, we become aware of variation of objectives within our own society. Such multiobjective planning is a key to engineering advancement. As we become aware of alternative technologies, we develop in innovative ability. Creative capacity is a key to engineering advancement. As we become aware of cultural richness, we may opt to work in a cross-cultural setting. Technology transfer (a two-way process) is another key to engineering advancement. And finally, as a become aware of such appropriateness, small-scale or large, we are reinforced in our choice of engineering as a career of social service.

Appendix.—References

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To Joint Venture, or not— Is It for Your Firm?[a]

By Duncan M. Black[1]

Introduction

More and more firms today are finding that joint venturing is an exciting way to expand and improve their firm's capabilities and profit potential. In many cases the teams developed include new disciplines for most of us such as economists, sociologists, real estate developers, criminologists, urban specialists, contractors, etc. In most cases the teams are tailored to meet the special needs of the client.

This paper will provide a "How To Do It Management System" to determine if the joint venture concept is for you or not. This will be done by pointing out many of the practical problems to help you eliminate guess work, avoid pitfalls, and reduce costly trial and error methods.

Definition

The term "joint venture" will be used in this paper synonymously with associations, consulting arrangements, partnerships, etc. One needs to define each and determine which is the best system to use in the particular situation you are involved in. The words will be interchanged throughout this paper to provide a variety of language.

A true joint venture requires the union of two or more firms into a new legal entity. In an association arrangement, the firms remain as separate legal entities. The assoication is usually done similar to a prime-subcontractor relationship. My personal preference is for the association arrangement rather than a joint venture. In either situation there are important implications for insurance

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liability. Prior to finalizing either type of arrangement, I recommend that you review the situation with your legal advisor and insurance carrier(s).

As today's projects become more and more complex and sophisticated, one finds the need to supplement their in-house expertise through an interprofessional temporary partnership of two or more organizations to meet the total needs of a project. This system has been going on for years and, in essence, there is nothing magical about it as you, as an engineer, have done this every time you have consulted with an architect. The big difference today is that teams are being put together in a marketing effort to go after a project rather than as an agreement after a commission has been assigned to a particular firm.

The idea of joint venturing is not new nor is it something that we should accept as a panacea to all of our marketing problems.

Achieving Change

One of the things that must be addressed very early is whether you, as a firm, wish to joint venture or not. One of the main reasons for joint venturing is to effect a change within your particular organization. You need to determine if the proposed change is necessary and if it fits within your firm's goals and objectives.

In developing a concept of whether to joint venture, you need to analyze your practice. In doing this, ask yourself this question: are you content with your present practice mix? In looking at the mix, you also need to determine if this is achievable on a continual basis or will certain of your service area's not be viable due to a change in the marketplace.

Another item to consider and get into is the scope of services that you are providing. From this, do you with to add additional services either through in-house expansion or through an association, or both? It is easy to expand your services through finding a compatible firm that you can joint venture with to go after projects. This may also be a way for you to determine if you should absorb or but out the other firm, or both. By working with them on one or two projects, you can determine if your organizations are compatible or not. This can be an easy way to look at a merger without having to go through the traumatic shock of an actual change until such time as a determination has been made that a merger would be agreeable and profitable for all concerned.

Joint Venture

At times, you may end up in a joint venture that is not of your own choosing. An example of this can be when a client of yours states that they have another project they would like you to work on, however, because of special consideration they also wish another firm to be involved. From this, they state that if you wish to have the job you will associate with firm X. This is what I call a forced joint venture, and by others a "shot-gun marriage." Sometimes this can be very beneficial and work out well, however, prior to accepting, I recommend that you talk, not only with the owner requesting this, but with the other firm to make sure that you are compatible. Even though it is hard to turn down work, you may find it more advisable to not have the work than to be in a situation that will prove detrimental to your firm and its image.

As an example of a "shot-gun marriage" type of joint venture, one happened to us a few years ago on a major shopping center. The developer interviewed our firm along with three others relative to providing complete services for the development. A few days after the interview we received a call stating that we had been assigned all of the site work and another firm would be doing the building. Because of the size of the project and the client, we ended up working out a mutually agreeable method of doing the work. This situation became even further confused as a public vote was required for the rezoning of the property. After the first rezoning failure, the developer stopped all work on the project. They then hired us again to do the site work and a different firm to do the building. In this case, the reason for going with the other firm is that they are a nationally recognized shopping center architect. They are using our expertise in the site development and for promotional activities relative to the rezoning and the national firm's name to quiet some of the concerns being raised by the local "no growth" advocates.

There are other times that you will end up in a joint situation because of a need. One of the needs may be that a major project is developing in your particular location and you find that all of the major firms from across the country are coming in after the project. With this in mind, you need to do an investigation of the best method for you to obtain the commission. This analysis will take a little time, however, if you set up a form it can be a fairly easy process. Some of the major marketing items that you need to consider are examined in the following.

Process.—Earlier we talked about the concept of analyzing one's practice to determine if a change is needed. The marketing process and the rest of this paper will be done on the assumption that you are interested in changing. With this in mind, one needs to establish a marketing program which includes looking at your background and experience, your ability to produce, the best method for improvement and expansion, not only in the areas that you are competent in, but also in the areas that you would like to gain experience in.

As part of the marketing process when you are analyzing projects, you need to determine how best to obtain the commission. Many times a joint venture can be the best way to proceed. A partial determination of this can be the concept of "would you rather have part of the pie, than none of it?" By this, I mean that if, through a joint venture, you can obtain the commission you will receive income, however, you will have to share it with another firm or firms. In my opinion it is better to do this than to try and get a project alone of which you have a very small chance of obtaining and thus not have any fee income for that particular project. This must be analyzed for each project you are going after.

At times, this may or may not be a choice of yours. You may be contacted by someone to associate for a project you are already chasing, thus causing a determination to be made on the best way to go. An example of this, happened to us recently relative to the new police building for the city of Lansing. This project was in the neighborhood of $14,000,000 and thus, attracted national attention. After the formal announcements of the start of the architectural selection process, our firm was contacted by five nationally recognized firms, all of which had extensive experience in criminal justice projects. Because of the nature of the project we had already set up an agreement with a criminal

justice consultant for programming and design consultation. After much consideration we determined not to associate with any of the other firms and later found that all of them joined up with local firms. As it turns out this was not good for those firms due to the fact that the Lansing Police Department has a history over the recent years that they would not hire a local firm and have gone out of town. Again, they went out of town and hired a firm (not associated locally) to do their project.

An item of market research missed by the nationals was the fact that they would have been better off alone. Another item to be learned from this is that one of the national firms obviously did not check out the credibility of their local associate. The particular local firm had just been informed by the city that they would not be retained for at least 3 yr for any more work within the city. Because of this particular association, the national firm did not have a chance.

Required Skills.—Upon determining that you are interested in a project you need to analyze the project to determine if you have the in-house skill to do the project. If not, then you need to consider having an association with a firm with the required experiences. This may also apply to the determination that, yes, you have the skills to do it, but because of the size of the project or the nature of the owner, you feel that you need to supplement your skills.

Through a joint venture your firm will be able to respond to change by creating a new combination of capabilities fashioned to the needs of a particular new type of project. This joint venture participation provides the background of experience in fields that normally are foreign to the practice of a particular firm.

Background and Knowledge.—I think you are all aware that no client wants his project to be a training ground. One of the most often asked questions is, "How many projects similar to mine have you done in the past?" If you haven't designed any similar type projects you need to be very quick on your feet if the question comes up during an interview. However, in most cases, you will not even get to the interview stage if the client is looking for a firm with a background in a particular project type. This is an especially critical situation for younger firms who do not have much experience as a firm, and also to old-time firms that have specialized in one or two particular project types. Through associating with another firm that has the proper background you can obtain instant experience to present to the owner.

Necessary Contacts.—It is not as critical today as it was in past years, but the situation still exists whereby having the proper contacts the chances of obtaining the commission are greatly improved. You need to analyze the particular project you are after to determine if this is an important factor and if so move appropriately. It may be that you can furnish the contact to a firm with the proper experience and conversely maybe you have the experience and need to associate with somebody that has the proper contacts.

Producing the Project.—In addition to the marketing of the project one must also analyze the ability to produce the project once the commission has been received. This is one of the problems that a marketing person faces if the firm management says "don't worry about production, just get the project, we'll worry about producing it later." Most owners today are sophisticated enough to be able to look at your firm and its ability to produce the work

within a reasonable time schedule. Relating to this, one must analyze their firm relative to production, ability to administer, finance, and manage the staff.

Administrative.—If the new project that you are after is much larger than you are used to, you need to analyze the amount of office and accounting services that this project will require. In most cases through proper set-up of a joint venture there will be minimal additional requirements and thus, should not strain your ability to administer the project. You may find, however, that if you have not done an association before that you prefer to have the other firm handle the administrative details. One of the critical items to consider is that usually the firm that does the administering of the project will be the prime firm and receive the most recognition (positive and negative).

Financing.—It takes money to start up any project. The nature of our profession has us doing our work and then receiving compensation. If one takes on a large project there can be quite an outlay of cash until the owner starts to pay. If you are in a good financial situation you will be able to go to a lending institution and use the projected fees as collateral. However, if you do not want to do this, it may be better to associate with another firm who can provide many of the services, and thus, cut down your actual cash outlay. This method of joint venturing will give one the advantage of being able to work on large projects with the feeling of being involved with a major firm, yet not have the large financial responsibilities.

Management.—In producing a joint venture project there are certain management skills that are necessary on a day-to-day basis. If you are a small firm of one or two people can you afford the time for one of your principals to manage the project? This needs to be looked at very closely and one needs to realize that if the project is large there is quite a bit of management time necessary. If you are not used to working on a project of this type or size, you need to be sure to allow yourself enough time. It may be, in this case, that the best bet is to have the actual project management done by your joint venture firm.

Another factor that can effect you is if you are used to working as your own boss and making all your own decisions without consultation with others, you may find a problem adjusting to an association whereby you have to clear certain things through other people. If the other firm is larger their managers are geared to this situation and may be able to handle the project easier. You must remember that proper management is the key to success of a joint venture.

Staffing Requirements.—In reviewing the proposed project you need to look at the numbers of people that will be necessary to produce the project. This relates not only to the numbers of people but the duration of time that they will be involved in the project.

If you are after a large governmental contract you probably will have to submit an actual breakdown of people, hours, and rates, etc. This can give you a handle on whether you can produce the project alone or not. In doing this analysis you should further expand the situation to see if this will tax your other projects. You need to remember that if your entire practice is dependent upon a single project and if that project stops for some reason, what will happen to your practice.

An example of this happened to us recently with a project which involved an exhibition hall, an arena, parking decks, and major site development, all

of which we have extensive experience in each type of the building projects. This, however, was one project and the owner anticipated proceeding immediately with all of the buildings at one time. After analyzing the project we went back to the owner and said that we had the experience, we wanted to do the project, however, because of the magnitude of the project we wanted to associate with another firm that also had the experience and had additional personnel available that could work on the project. The owner appreciated our candidness in this situation and was very agreeable to our developing the association.

Although we could have produced this particular project alone, it would have been a great strain on our staff and as it turns out we were very fortunate to have the particular associate that we do. The reason for this is that the project which we were gearing up to do has been put on the shelf for at least 6 months and possibly a year. If we had added additional staff and been completely geared up to handle the entire project we would have had to lay off about 25%–50% of our employees due to the sudden lack of work. Because we were not placing all of our expectations on this one project we were able to shift the personnel assigned to it to other projects and thus not have any lay-offs. We also will be able to gear up quickly for our portion of the work at such time as the project proceeds.

Another item that is going to prove beneficial on this is that the owner is now looking at the possibility of going to design build for portions of the project. Since our associate firm has a subsidiary to do design build work, we can probably obtain this commission as well. If this did not happen we would probably be forced into working with some large general contractor who we may or may not be able to work with.

Summary Evaluation.—In many cases one will do a review of the aforementioned items in their head and have a pretty good idea of where things are. However, to be more accurate we have developed a form similar to that used by a number of firms that we have associated with to do a more thorough analysis of the need to associate. Included as Appendix I of this paper, you will find a copy of the form that we use.

Special Requirements.—At times the owner of a project may have some special requirements which if you are to remain competitive will require you to become part of a joint venture. Some of the items that may develop are: local firm, minority participation, full in-house capability, specialized experience, design awards, etc. If you do not have the particular special requirement that the owner has and you really want to go after the project, then you will need to associate to meet the needs.

One of the major items that is cropping up lately is the requirement for minority enterprise participation. In the state of Michigan the firm does not have to be a minority firm, however, you must obtain a certification from the state showing that you meet the Equal Opportunity Employment (EEO) requirements. This requires a yearly filing of your employee mix as well as your current EEO Policy.

In some particular situations you may be required to have a minority firm represented as part of your team. If this is so, most professional societies now have listings of qualified firms. My recommendation is that if you do not know of any firms, that you check on their background prior to agreeing to any association. During the recent Economic Development Authority (EDA)

go-arounds, a number of people tried to pass themselves off as minority enterprises, and late in the project were found out which caused all sorts of problems for the owners of the projects. In any case, if you are going to associate with someone be sure to check on their background prior to going into something blindly.

Choosing Your Partner

Now that you have determined the need to joint venture for a particular project you are faced with the dilemma of how to select who to work with. Since this will be a long-term association you need to proceed with caution and establish the gound rules early. To do your analysis refer back to the form that you did rating your strengths and weaknesses and find out what you need in the way of strengths from another firm to compliment yours.

As an aside, being active in various professional organizations will help you in establishing contacts, not only locally, but across the country. I am a member of the Society for Marketing Professional Services and through participation in that organization, know people in most states. Where I do not know someone, I have contacts who can give me a lead on a firm or firms to contact if the need to joint venture in a particular area develops. These connections help me get a good handle on a firm that I might want to bring into my local community.

Once you have established what you need you must start looking at firms that you think can give you the required supplemental needs. I feel that as you break this down, if you cannot furnish at least 30% of the services that you should consider not getting involved in the particular project.

One way to do this is to keep a record of firms you have had contact with and their backgrounds, including strengths and weaknesses. From this reservoir of knowledge you can then fairly quickly go through and pick out the firm or firms that you may wish to talk with. I am sure that some of the large firms have computer systems that do this for them, however, because of the human nature of the proper mix of people and personalities, I feel it is best to keep this on a more personal basis. As mentioned earlier there are times when you do not get to make the choice and the so-called shot-gun marriage is developed.

Another situation that may develop is that one of your local firms really would like to stay local, however, the president of the firm is enamored with the idea of having a so-called nationally recognized designer do his project. Under this situation you may wish to go out and associate with the big name person to come in and do the design concepts and you take over from there. This will allow the company president to get his moment of glory and will also allow the building manager to have his local people providing the technical competentness and closeness for response.

As example of this that happened to us a number of years ago was for the University of Michigan All Events Building. Mr. Crisler was the athletic director and he wanted Dan Dworsky to design the project. Dan was an All-American football player for Mr. Crisler and is a nationally recognized architect in California. Concern developed at the University relative to his providing on-site inspections, having a large enough staff to produce the project, plus being knowlegeable of the State of Michigan codes. The University

approached us and asked if we would be willing to associate with Dan to do the project. We, of course, were and the association was set up and an excellent building resulted.

Other types of teams that may develop will evolve around supplementing your own staff with additional specialists that may or may not be on staff. You may get into a design build team situation or even more complicated one of which a team is made up of a designer, builder, land financier, manager, etc. You may find that your team, because of a major complex of buildings, and environmental conditions, will involve many disciplines including architecture, engineering, planning, landscape architecture, systems analysis, real estate consulting, sociologists, psychologists, economists, financier, contractors, property manager, computer specialists, etc.

Whatever you develop, be it a combination of two or more organizations, things can be done very smoothly as long as the up-front agreements are put together equitably. This means that proper divisions of work are established and lines of communication and authority are agreed to prior to the start of work. Things may have to be adjusted during the project development process; however, if the ground rules are set early it will be easy to make the necessary adjustments. If these agreements are not established early you may find that because of misunderstandings the whole association will have to be dissolved.

Selection Process

As mentioned earlier contacts within various professional societies can help you in selecting compatible firms. You should also pay attention to various professional magazines. Particular articles may develop on a subject where you are looking for an expert in that area. This will give you a lead on a firm or firms that will have the expertise you are looking for.

Another group to consult with are contractors in the particular area of the project. These contractors will have knowledge of the various professional service firms in their area and will be able to give you some fairly candid overviews of the various firms. In evaluating the contractor's remarks, just be sure that if he gives a particularly bad reference that this is not some firm that has made him toe the line thus, made him mad. At the time you decide on a firm that you would like to talk further with, you should set up an appointment to go to their office. Let them know that you are coming in to talk with them about the possibility of an association and this will give you a chance to meet their people and see their office and evaluate their ability to work with you. While in their office be sure to be there at least part of the time during normal working hours to be sure that when they say they have so many people on staff that you can see these people and not just empty tables that have had something put on them to make them look as if they are being used.

Conversely, prior to setting up the final agreements you may wish to have the prospective firm visit your office so that they can feel confident of you as an organization. This will also help in the start of the communication process relative to proper management and organization of a project.

Defining the Relationship

Earlier in the paper an examination was held analyzing the joint venture.

During the process an evaluation form was used and this form can become the basis for starting the definition process. Based upon your needs as determined from the evaluation form, I suggest that you draw up an interoffice agreement. The agreement will become the legal document for the association of the various parties and so should be treated and reviewed accordingly. Some of the major items to be included are: (1) Name of project; (2) owner; (3) names of joint venture partners; (4) date; (5) responsibilities of partners (see Appendix II); (6) fees and method of payment (see Appendix III); (7) reimbursements; (8) publicity: who named how; (9) liability insurance; (10) engineering and landscape services; and (11) signatures of agreeing parties.

Appendix II is a form we have adopted as part of an interoffice agreement. The scope of work is based upon using American Institute of Architects (AIA) Documents for the agreement between owner and architect. You can develop your own based upon the scope of work designated in your engineering agreements.

Appendix III relates to having a good determination of the fee for the project. Do not just go on an assumption. You can also combine fee distribution with work allocation as shown in Appendix II.

Liability insurance is an item that needs to be reviewed by both parties. If you have a true joint venture you will not be covered by your normal insurance so you will have to take out project insurance. If you are in an association be sure your associate has insurance. Many firms do not carry liability insurance so if you do be sure your associate does. In today's society of consumerism, I recommend that you review the situation with your insurance agent and possibly your legal advisor. There are variations from state to state that need to be checked if you are working out of state.

Learning Process

If you move into a joint venture with a positive attitude a lot can be learned. Many of the ideas will be subtle variations while others may be totally new. The ability to enter a new field is probably the most useful reason for a joint venture. The second is to do projects larger than you can do alone. I feel that one of the upcoming activities that will cause many of us to joint venture is the emerging client requests for design build.

Once you have done one or two projects of a new type with a joint venture partner, you will be able to go after projects on your own. If you do an association and act as prime in the joint venture mentioned in the foregoing, it will be easy to claim the experience. If you are not prime you will have to work your proposal carefully to develop as much credibility as possible. In either case, the association has given you the learning experience to be able to do a new project type on your own.

Another experience a joint venture can give you is the ability to learn new techniques be they in marketing, administration, production, construction administration or personnel management. Whatever the arrangements and division of responsibility, you will be working with others and should learn from the experience. In many cases you will learn that you are really a very strong and up-to-date firm. Many times a smaller firm has an inferior feeling from size. When you start working with a large national firm you most likely will

find that you have all the necessary skills and just need self-confidence and experience in working on a large or new type project, or both.

Summary

After at least analyzing the need, but more likely after participating in a joint venture, you should do a summary and analyze if things have been beneficial and if you should do another or not.

As the automatic summary you should analyze:

1. What has been learned?
2. New management and administrative techniques?
3. New field of practice?
4. Reaffirmation of old skills?
5. The big feeling?
6. The new client?
7. A broadening experience?

The final analysis must relate back to a definition of the future of your firm. The definition relates to where you are now, where you want to go and will a joint venture help you get there?

To me an association is a very positive step in developing a strong firm. So much can be learned that can enhance your firm that the trials of coordination are worthwhile. In the end you may find that a joint venture is not for you. If this is due to a proper analysis then you have accomplished the intent of this paper which is to develop your firm into an on-going viable organization capable of doing the type of work you want at a profit and feeling confident about it.

Appendix I.—Exhibit A

Prospect Evaluation Form

This form is to be used to evaluate a potential project relative to our ability to do the project alone, in association with another firm and/or firms, or possibly do not go after.

Name of Project: _____
Owner: _____
Address: _____
_____
_____
_____
Telephone: ( ) _____

Location of Project _____
Estimated Cost: _____
Estimated Time Schedule:
Selection Date _____
Construction Start _____
Construction Complete _____

REQUIREMENTS	% we can furnish	% help required
Required Skills		
Background & Knowledge		
Necessary Contacts		
Marketing Skills		

Administration
Financing
Management
&
Staff Production

Do we proceed: Yes _____ No _____

If Yes: Alone: _____ in association with _____

(Name of Marketing Representative)

Date:

APPENDIX II.—EXHIBIT B

As part of setting up an association one needs to prepare an interoffice agreement. There are forms that can be used which are already printed or you can develop you own. Each situation needs to be studied for what is proper.

The AIA has developed two forms which are helpful:

1. AIA Document C 801—Joint Venture Agreement, Mar. 1972 edition.
2. AIA Document B 162—Scope of Designated Services, Nov. 1977 edition.

Document C 801 is a standard form of agreement developed for Joint Ventures. It is similar in nature to the Standard Architect-Engineer Agreement. Document B 162 lists each service (including a description) that is normally provided with check-off columns indicating who is responsible for providing the service. If you are interested in more detail, I suggest you contact:

The American Institute of Architects
1735 New York Avenue, N.W.
Washington, D.C. 20006

Telephone (202) 785-7300

We have developed our own format; a marked up copy of a sample agreement follows.

PROJECT:	EMOL-Paper
OWNER:	This is being prepared as a sample of typical inter-office agreement we use till formal contract with owner is signed.
NAME OF ASSOCIATION:	WARREN HOLMES-KENNETH BLACK CO.—Lansing, Michigan EMOL Committee of ASCE
DATE:	January 10, 1980

WHEREAS, WARREN HOLMES-KENNETH BLACK COMPANY (H-BCo) is responsible for the total services to be performed under that certain Owner-Architect Contract between H-BCo and Owner of the above named project; and

WHEREAS, H-BCo desires to delegate to ASCE—Committee on Engineering Management at the Organizational Level certain of the services called for in said contract:

NOW, THEREFORE, H-BCo and EMOL agree as follows:

1. EMOL's major responsibility shall be the Programming, Planning, and Architectural Schematic Design and Design development Phases. H-BCo's major responsibility shall be the Construction Documents Phase, Receipt of Bids, and Construction Phase.
2. Each firm shall participate in each phase of the architectural service as indicated on the attached form, Division of Responsibility for Architectural Service. The division of responsibility for architectural service may be changed only upon the approval of the associated firms.
3. H-BCo and EMOL agree to the conditions of the Owner-Architect Contract and the requirements which apply to each firm's major responsibility.
4. H-BCo will provide all engineering services required by the project in all phases.
5. Trips between offices of the associated firms will be required for the purpose of coordinating the project. Cost of such travel and living expenses will be a part of each firm's fee and will not be considered as an item of extra cost. The number and length of time of such trips will be determined as the project demands.
6. H-BCo shall bill the Owner for architectural services as provided in the Architect-Owner Agreement. Payment of fee to the other firm will be made by the firm responsible for billing within ten (10) days after receipt of payment from the Owner.
7. Long distance calls shall be paid for by the firm initiating the call.
8. All architectural publicity must have the approval of both associated firms. On local (State of Michigan) publicity H-BCo will be named first. On national publicity EMOL will be named first.
9. Cost of printing for the Architectural Schematic Design and Design Development Phases shall be paid for by EMOL. Cost of printing for the Construction Document Phase shall be paid for by H-BCo. Cost of printing for Bidding and Construction Phases will be paid for by the Owner.
10. The cost of special consultants other than Structural, Mechanical, Electrical, Food Service, and Civil Engineering, *when not paid for by the Owner,* shall be paid for by the associated architects on a prorated basis, based on the total division of the basic fee. Special consultants selected must have the approval of both firms.
11. H-BCo and EMOL have certain architectural responsibilities designated in this agreement as major and minor. It is understood and agree that as between H-BCo and EMOL each shall have sole responsibility for the services for which the respective architect has been assigned the major responsibility.
12. H-BCo and EMOL each agree to procure and maintain architect's and

engineer's professional liability insurance in a minimum amount of $1,000,000,00.

13. It is understood that the basic fee will be divided as follows: (See attached breakdown of responsibility.)

WARREN HOLMES-KENNETH BLACK COMPANY

ENGINEERING MANAGEMENT AT THE ORGANIZATIONAL LEVEL.

Appendix III.—Exhibit C

This analysis is to show you how problems can develop over fees. Various organizations, states, architects, etc. work to different basic fees. The variance can be seen in the following tables which are based upon a high school project:

Basic Compensation—Construction Cost, as a percentage

Construction Cost	District A	District B	District C	District D
500,000	6.9	8.8	5.9	5.6
1,000,000	6.4	7.8	5.8	5.3
3,000,000	5.7	6.8	5.0	4.8
5,000,000	5.5	6.3	4.8	4.6

Example: You develop a project in District A and Joint Venture with a firm that is expecting to work for District B's fees. You have agreed to 30% as their share of fee.

YOU 3,000,000 @ 5.7% = 171,000 @ 30% = $51,300
ASSOCIATE—3,000,000 @ 6.8% = 204,000 @ 30% = $61,200
Difference $ 9,900

If the fee was not worked out ahead of time you could end up paying your associate $9,900 more than you expected. This means that you actually are giving your associate 36% of your fee.

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MANAGING JOINT VENTURES IN LARGE PUBLIC PROJECTS[a]

By James L. Lammie[1] and D. P. Shah,[2] Members, ASCE

INTRODUCTION

The Metropolitan Atlanta Rapid Transit Authority (MARTA) is building the first heavy rail rapid transit system in the southeastern United States. The initial 6.7-mile (10.8-km) East Line of the billion dollar first phase of the Atlanta system was opened in June, 1979, 6 months behind schedule and within 5% of the 1975 budget. The second leg of the phase A system, the 5.1-mile (8.2-km) West Line, opened on schedule in late December 1979. The newly opened line is carrying more patrons than forecast and the system has far exceeded expectations with over 80% car availability and over 97% on-time performance. The first north/south increments are expected to open in 1981 and 1982. The MARTA system map, Fig. 1, shows the currently planned $3 billion plus, 53-mile (85.3-km) rapid rail system with 39 stations. The design and construction schedule for future extensions is immediately dependent upon Urban Mass Transportation Administration (UMTA) approval to construct with local funds under a letter of no-prejudice and ultimately on the pace of future 80% Federal funding. Various aspects of the MARTA system are discussed in several preprints issued for the ASCE Annual Convention held at Atlanta, in October 1979 (2).

One of the critical early decisions for MARTA was the selection of a single general engineering consultant for design and construction services rather than the alternatives of multiple prime consultants as was done on the Washington Metro, or of expanding in-house capability as normally done by the larger, more mature transit systems with continuing expansion and upgrading programs. MARTA made a detailed review of the experiences of other properties and elected to delegate day-to-day technical management to the general engineering consultant, but to retain authority for all policy, cost and schedule decisions.

[a]Presented at the April 14–18, 1980, ASCE Convention and Exposition, held at Portland, Oreg. (Preprint 80-171).

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This required a substantial MARTA staff capable of independent studies, analyses, judgments, and reviews.

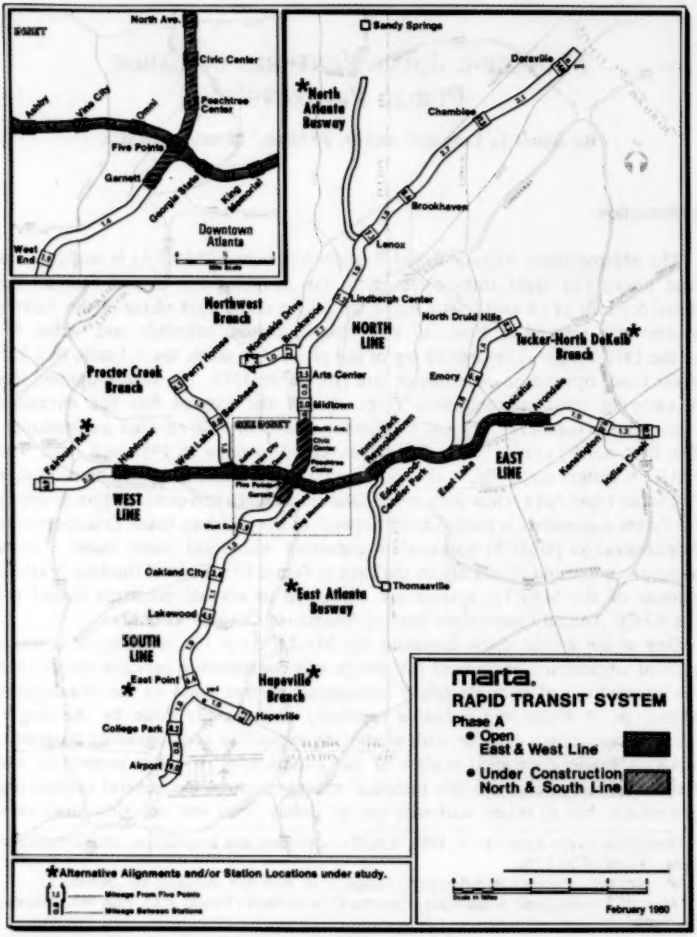


FIG. 1.—MARTA System Map

This paper will examine the general engineering consultant's functions to see how it was organized, how it changes, how it accomplished the design and construction tasks, and how it supported and complemented its single client,

MARTA. Selected aspects of cost and schedule control, Equal Employment Opportunity (EEO) program and wrap-up insurance will also be reviewed due to their importance in this project.

Joint Venture Structure

In 1972, a joint venture of Parsons Brinckerhoff Quade and Douglas, Tudor Engineering Company and Bechtel (PBTB), was selected by MARTA to serve as general engineering consultant. At the time of selection, PBTB was also serving as the general engineering consultant for the Bay Area Rapid Transit District (BARTD), in San Francisco, Calif. In 1976, during a renegotiation of the annual contract with MARTA, Bechtel withdrew from the joint venture. The remaining two firms have continued in the general engineering consultant role as Parsons Brinckerhoff/Tudor (PB/T), a joint venture dedicated exclusively to the MARTA project. The severing of a long-term beneficial relationship is always difficult but it was especially so for the two remaining joint venture members to lose the resources and support of the 20,000 man Bechtel organization. The restructuring was accomplished in a professional manner with a personnel loss of less than 5% to the withdrawing partner. Key Bechtel personnel continued to support the joint venture for almost a year until critical skills could be replaced. The resources of PB/T proved to be adequate to provide back-up technical capability for PB/T. Although the departure of Bechtel precipitated a major change, in retrospect, it was only a minor factor among those affecting the joint venture organization.

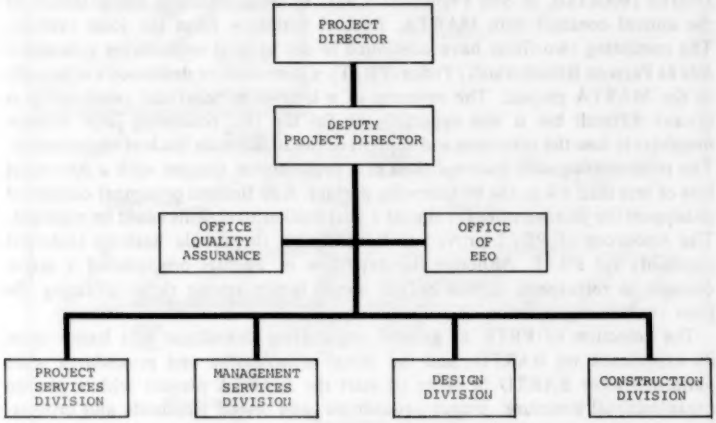
The selection of PBTB as general engineering consultant was based upon its experience on BARTD, and the initial organization and procedures were patterned after BARTD in order to start the MARTA project with a proven organizational structure, proper procedures, and tested standards and criteria. However, the general engineering consultant organizational structure and functions evolved rapidly and continuously due to the operating policies of the MARTA Board, more restricted delegation of authority, different design philosophies, unique system lay-out, and strong technical capabilities of the MARTA staff. The rate of change was faster than normally expected during the life cycle of a large, single purpose project. Fig. 2 shows the PBTB organization in early 1975 during the peak design activity. Fig. 3 shows the PB/T organization in early 1978 when both design and construction were at high level.

The joint venture of PBTB and later PB/T was established as an independent organizational entity with its own accounting and personnel departments, separate payroll, insurance and fringe packages, and local administrative procedures, all tailored to the needs of the project. The independent field office approach was based on: major project scope and extended duration, geographical separation from the corporate offices and most importantly, provision of flexibility in terms of contract form and decision making. The joint venture principals, functioning as a board of consultants, advised on most major design decisions during the early years of the project; however, as the project moved to the rapid pace of construction, they remained involved primarily in key personnel and administrative policy decisions with few opportunities for technical guidance.

The joint venture organization gradually evolved into a "flat" structure as shown on Fig. 3 with shorter, more responsive lines of communication as the

project emphasis shifted from design to construction. Support services were cut to a minimum and numerous personnel changes were made to develop a totally project-oriented group. The basic organizational philosophy of the joint venture can be summarized as follows:

1. The joint venture must reflect the organization of MARTA so that a clear counterpart staff relationship is maintained at all times. The decision by MARTA to establish a comprehensive check and balance system dictated parallel organizations.



STAFF STRENGTH

YEAR	1975	1976	1977	1978	1979
PB/T	495	660	550	580	520
MARTA	120	125	145	145	140

FIG. 2.—PBTB Organization Chart in Early 1975

2. The joint venture must reflect changes in relationships with MARTA in terms of authority, function, and structure.

3. The joint venture organization must be dynamic and change frequently. Change must become the norm so that acceptance of change is not a major behavioral issue.

4. The joint venture organization must provide a clear chain of responsibility for all distinct project elements.

5. Control mechanisms such as special reports or committees are required to monitor the organizational interfaces between major project elements and between major functions, e.g.: design versus construction.

6. In a client-consultant relationship, the final organizational determinant is people and their personalities. The people-decisions are the most difficult organizational decisions.

Facilities Design Process

Design of a half billion dollars of line and station facilities on an accelerated basis could be accomplished only by bringing to bear the coordinated efforts of a large number of architect/engineer teams. An extensive solicitation developed a lengthy list of qualified architect/engineer joint ventures with experience in rapid transit design. Some 31 design teams, representing joint ventures of more

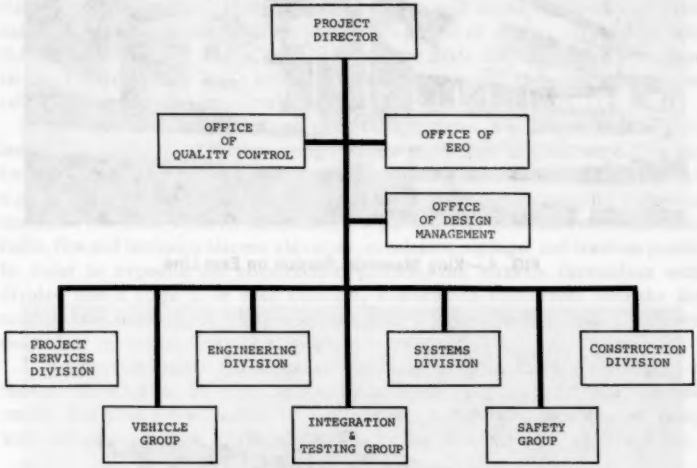


FIG. 3.—PB/T Organization Chart in Early 1978

than 70 firms of engineers and architects, were placed under subcontract to PB/T to complete the design of individual stations and line sections. These firms were brought under cost plus fixed fee contracts by the standard procedures utilized in most Federal contracts: (1) Solicit interest; (2) develop a short list; (3) interview and rank the teams based on qualifications; (4) select; and (5) negotiate the contract. These initial selections and the subsequent design efforts were impacted on by a set of unique circumstances:

1. Required UMTA approval of the initial form of the design subcontract as well as for each architect/engineer team selected initially caused extensive delays in issuing the notice to proceed. These delays consumed time allocated for design and put most architect/engineer teams on a crash schedule in order to meet target construction contract advertise dates.
2. The selection process placed heavy emphasis on minority participation

and attempted to insure that on each arthitect/engineer team, at least one of the major design disciplines would be assigned to a minority firm. This created

FIG. 4.—King Memorial Station on East Line

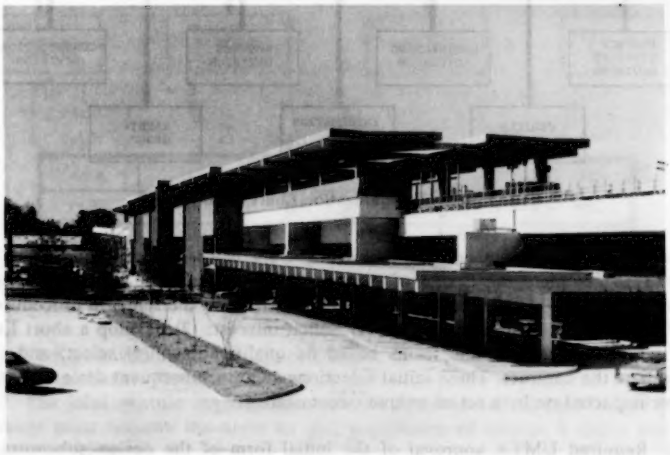


FIG. 5.—Hightower Station on West Line

some difficulty due to the limited experience of many of the newer minority firms in rapid transit design.

3. In order to spread the responsibility for the design over as broad a base as possible, the MARTA Board adopted a policy of "no repeat design assignments" for the architect/engineer firms. This meant that, even on later selections, all new participants would go through a learning curve tc become familiar with MARTA criteria and standards as well as the special requirements and regulations of the affected outside agencies and municipalities.

4. The design philosophy required that each station be designed as a low maintenance, unmanned facility which would reflect the character of its neighborhood. This, coupled with the variation in site condition, minimized the opportunities for standardization and made each station truly unique. Figs. 4 and 5 show MARTA stations which typifies such design philosophy.

5. An early planning decision was made to construct the MARTA line in transportation corridors along existing railroad and street rights-of-way. This called for extensive coordination and development of master agreements with the affected railroads, cities, counties, and the State Department of Transportation. This ultimately led to extensive reconstruction and upgrading of impacted railroads and streets to modern design criteria.

6. In order to achieve target revenue service dates, a policy of concurrency led to the initiation of facility design before the design criteria were firm and before full definition of interfacing systems was available. Each station contract, e.g., was to provide the necessary conduit and facility envelopes for follow-on contracts for train control, telephone, public address, closed-circuit television, radio, fire and intrusion alarms, elevators, escalators, signage, and traction power. In order to expedite the construction process, the stations themselves were divided into a stage I, or shell contract, constructed concurrent with the line section and stage II, or finish contract, which could be designed at a slower pace after the initial contract was bid.

7. To provide better definition to the designers and to take advantage of the time required for the selection and approval process for the architect/engineer teams, line design was carried to a 30% level (preliminary), and station design was carried to the 15% level (conceptual) by the joint venture in-house effort.

Design Project Management

Within the joint venture, an in-house contracting officer's technical representative (called a project unit manager) was designated for each design contract. The unit manager's responsibility was to coordinate and expedite the design, to respond to technical questions and issues, to monitor and report on the status of design, and to serve as the focal point for design review comments and instruction flowing to the architect/engineer team. Design review for milestone submittals at the 30%, 60%, 90% and 100% levels was conducted by the joint venture's design review group for the civil and structural disciplines and within functional departments for architectural, mechanical, and electrical. The level of review was merely to insure conformance to criteria; the staffing and project schedule did not allow detailed design checks. The responsibility for detailed checking remained with the architect/engineer team. A concurrent review was conducted by the MARTA staff along with coordination with the cities, railroads, and the State Department of Transportation.

From the beginning, design schedules slipped due to the UMTA approval process and outside agency agreement issues. The joint venture, MARTA and outside agencies, such as the city of Atlanta, found that they were not staffed to keep pace with the planned level of design reviews. With the press of schedule and the lateness of many of the review comments, coordination within the architect/engineer team became difficult since its design groups were often geographically spread throughout the United States. Interdisciplinary checks, particularly among the architectural, mechanical, and electrical disciplines, were usually the last tasks to be addressed, and this effort suffered severely under schedule compression. As new designs were developed, the in-house design management group was stretched thinner. This failed to recognize that a cost plus fixed fee contract, by its very nature, placed a higher level of management responsibility upon the owners representative and tended to reduce the architect/engineer's responsibility to a best-efforts basis. Thus, internal management controls should have been increased rather than diluted.

Design Evolution

As a result of this early experience and the somewhat reduced pace of design in late 1979, several changes were made in the design process. The most significant is that MARTA assumed responsibility for developing the conceptual designs using joint venture staff to augment its own staff when required. An orderly, rather than crash, schedule permits extensive coordination with outside agencies during the conceptual design. Great emphasis is now placed upon right-of-way acquisition strategy, so that problem parcels can be identified early and, if possible, avoided. Of some significance here is that MARTA does not have condemnation authority and must work through the local governments. Drainage requirement coordination with the affected municipalities and certification of easements also receive early attention.

The conceptual design is carried only to that level of completion required to insure coordination and permit negotiation of a firm contract with the architect/engineer team. For line sections this may be as low as 8%, while for stations, it may be on the order of 10%–12% design completion.

Another major change is that all architect/engineer design contracts are now a fixed price single lump sum including both preliminary and detailed design. With firmer criteria, increased standardization and availability of existing stations for models, cost plus fixed fee contracts are no longer appropriate. This has the added advantage of placing the responsibility for the internal management of the design directly upon the architect/engineer team and reducing joint venture in-house staff requirements. The joint venture design project manager will monitor fewer contracts concurrently and will be more involved in the technical details of the design, rather than primarily in expediting and coordinating.

Additional time is now allocated in the project schedule for design reviews by the joint venture to include random detailed checks of each functional discipline. The independent design review group has been eliminated and all reviews are conducted in the functional discipline departments. The joint venture design project manager has a project life cycle responsibility and will continue as the technical representative for design services during construction.

There is a major change in facility contract packaging philosophy in order to simplify interfaces during construction. Station contracts are not bid as a total package rather than as stage I and stage II. This not only facilitates construction, but also coordination and checking during design. The design to construction time, however will be increased with the reduction in fast tracking or concurrency. Many of the systems which were previously handled as separate contracts are now incorporated within the station design, e.g., public address, lights, closed-circuit television, telephone, traction power, trackwork, elevators, and escalators. The most significant change from earlier contracts is that many of the systems which were only concepts when the initial stations were built are now operating systems. Contracts, such as train control, will be bid in the future more as hardware rather than performance type contracts; thus, the facility interfaces, spaces, and conduit requirements, can be well defined by criteria.

Construction Management

Project organization for construction management is shown on Fig. 6. As with all other functions, the organization reflects a check and balance system

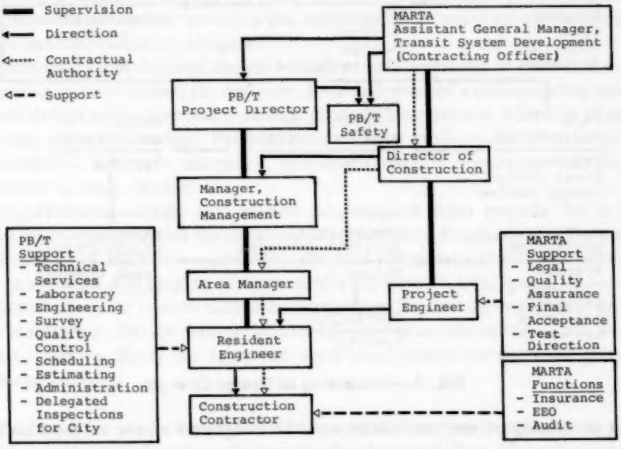


FIG. 6.—Construction Management Team

between MARTA and the joint venture. While the joint venture resident engineer is designated as the specific point of contact with the contractor, the resident engineer has no authority to modify the contract by change notice or change order. A delegation of interim approval authority of $5,000 is made to the joint venture area manager and the MARTA director of construction, but all contract modifications must be approved by the contracting officer. Fig. 6 shows, by dotted line, the channel for delegation of contractual authority.

On matters of insurance, EED or audit, MARTA staff elements have direct

contact with the contractor. The joint venture safety department which has a dual reporting channel to MARTA, will normally work through the resident engineer, but may deal directly with the contractor on matters involving protection of life and property. On general inspection services, there is also a split of responsibilities.

1. Factory inspection: structural—PB/T technical services; and electrical mechanical—PB/T quality control.
2. Release for shipment: mechanical electrical—MARTA quality assurance.
3. Construction inspection: PB/T resident engineer.
4. Equipment test: level 1—PB/T resident engineer; level 2—PB/T engineering; and level 3—MARTA test director.
5. Final acceptance: MARTA board of directors.

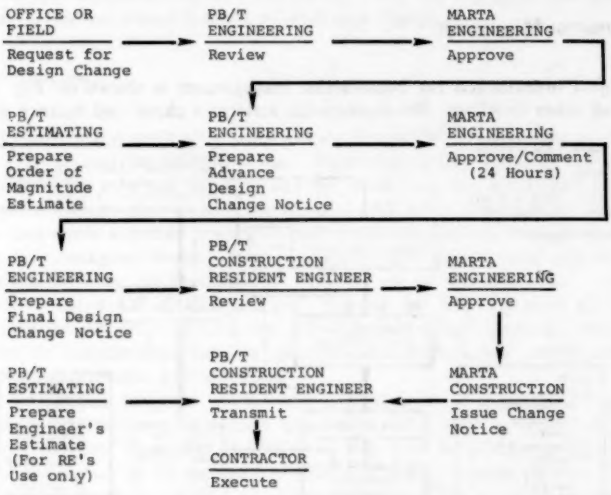


FIG. 7.—Processing of Design Change

The separation of responsibilities and the integrated nature of the check and balance system is well shown in the processing of a design change notice. As shown in Fig. 7, each design change is reviewed by the MARTA engineering division three times: first for need, second for concept, and finally for detailed review. Although appearing cumbersome, the total cycle can be completed in a matter of hours for critical items. More normal processing for the entire cycle is design time plus 1 week. The advantages to the system are the elimination of nonessential changes, early input of cost consideration and alternative concepts, and tight control of contract dollar contingency.

The construction management of the MARTA project is comparable to that on other major Federal public works project except for the limited authority delegated to the resident engineer, a greater split of functional responsibilities

between various staff elements, a tighter system of checks and balances, and a combined team approach between MARTA and the joint venture. This approach to construction management has served with little change since the early days of the project.

Cost Control

The MARTA project is currently projecting completion of its first phase of 13.7 miles (21.9 km) and 17 stations within 5% of the early 1975 budget of $1.017 billion, despite higher-than-projected rates of inflation. Resolution of outstanding claims on construction and equipment contracts could push costs up another 5%. Control to date has been effected by recognition that the need for cost control consciousness must pervade every step of the project life cycle as summarized in the following:

1. Systems basis of design—sets the relative degrees of austerity and complexity (e.g., sophistication of control systems) and extent of redundancy.
2. Criteria—sets the level of standardization and provides bases for initial cost reduction reviews.
3. Project conceptual design—selection of station location and line configuration (subways, aerial, at-grade) provides maximum opportunity for cost savings. Conceptual design review provides the last significant point of owner changes to scope before release to designer.
4. Preliminary and detailed design—requires establishment of firm cost target expressed in current dollars for designer. Establishment of a cost-trending system monitors design and construction costs and identifies policy or schedule changes which may impact on budget. Periodic reviews must evaluate the latest estimate, constructibility, schedule adherence, and cost reduction proposals even though the forecast is under budget.
5. Construction—design and outside coordination must provide for a constraint-free environment for the construction contractor. Emphasis must be placed on availability of right-of-way parcels, advance utility relocation, and provision of adequate work and staging areas to achieve minimum total cost.
6. Schedule—cost control measures must recognize that the major cost growth factor is inflation. Design refinements which impact on the schedule are usually not cost-effective. Early bid dates and rapid construction are the most effective cost reduction tools.

Within the joint venture and MARTA, emphasis on these cost control points has led to accelerated efforts during the conceptual design where a minimum expenditure of added resources can gain maximum schedule compression. Once the design has been given to the architect/engineer team, schedule achievement is carefully monitored to insure timely advertising. During construction, priority is placed on rapid problem solving to minimize opportunity for delay claims from the construction contractors. Frequent review of design and construction status and problem areas is the essential project focus.

Project Schedule

The driving motto on the MARTA Project is "Find a Way to Move Ahead." Public and political attention is always focused on opening day on a new transit

system and benefits to the public do not accrue until all systems are operational. The schedule is the primary control device for bringing the system's component contracts into coordinated integration to provide an operating entity.

On MARTA, for each new line segment, a project master schedule is established based on a critical path method network which is computerized for ease of calculations and reporting. The schedule contains established milestones which are within management's control. While each construction contract requires the monthly update of its critical path method network, only intermediate and major milestone events are normally displayed on the project master schedule. Schedule performance for each contract is summarized weekly in a manually prepared status report of progress and problems with inputs to the project master schedule on a monthly basis. The project master schedule provides the tool to determine the remaining float and to focus attention on critical problems areas. Individuals in MARTA or PB/T are assigned to develop solutions or work-around alternatives for the identified critical problems.

Constraints to schedule accomplishment most frequently appear as interface discrepancies between the facility contracts and follow-on systems (train control, communications, etc.) contracts. Each such discrepancy is tracked on a weekly basis until the constraint has been removed. The solutions to schedule constraints call for coordinated action by MARTA and joint venture staff without regard to assigned responsibility or delegated authority.

Problem analyses and clear presentation of alternatives, rather than placing blame, are the primary elements of the problem-solving process. The question of who or what is to blame then becomes a proper element of the effort to avoid future difficulties. The scheduling staff is, therefore, a vital element of the problem-solving and planning efforts.

Equal Employment Opportunity

Since its beginning MARTA has had a strong commitment to the goals of EEO as previously reviewed in Civil Engineering (1). The MARTA program includes the following factors which are essential to the successful execution of any EEO program.

1. The MARTA EEO program has received the strong support of the MARTA board of directors which early adopted a policy statement in support of EEO.
2. MARTA has always had a strong and experienced EEO staff.
3. MARTA adopted a flexible approach to achieving a maximum EEO commitment from all contractors on minority business participation. This approach recognized that in the beginning of the program, it would be necessary to accept a commitment less than that desired in order to stress the development of experienced minority firms.
4. MARTA has always carefully reviewed firms presented as minority businesses and has quickly disqualified those organizations which were considered to be figurehead structures or those in which the minority firm had been relegated to nominal tasks.

Marta has been successful in all areas in the implementation of its EEO program. In design contracts, both MARTA and PB/T EEO officers are members

of the selection committee which develops the short list, conducts the interviews of qualified firms, and makes the final recommendation for selection. In general, the goal in design contracts has been to provide for a range of 14%–19% minority commitment. In construction contracts, percentage goals have not previously been specified in the bid documents. However, prior to contract award, MARTA negotiations with successful low bidders have allotted about 17% of the construction contract dollar value to minority-owned firms, against a MARTA EEO program goal of 16%–21%. MARTA found, in general, that the larger the construction contract, the easier it was to get a sizeable commitment for minority business. Past experience demonstrated that on smaller contracts, nonminority firms were normally the successful bidders and had the resources to do most of the work with their own forces. With larger contracts, MARTA attracted prime contractors from throughout the country who relied more on local subcontractors and were, thus, more able to commit to meet higher minority business participation goals.

The effectiveness of the MARTA program has been enhanced by a mandatory reporting system which insured that commitments were met. Contractors who were unable to meet a minority business commitment in a specific area were required to substitute a commitment in other areas. A failure by a contractor or its subcontractor to meet commitments resulted in the stopping of all payments until the contractor's plan could be reviewed and mutually agreeable commitments renegotiated. While no construction contractor has yet been defaulted for failure to meet minority commitments, there have been several occasions in which the default stage was approached and were resolved through last minute negotiations. In one instance, a design firm was defaulted for not developing and meeting an acceptable EEO commitment.

MARTA adopted a revised affirmative action plan in 1979 which was dictated under new UMTA policy. This new plan now has specific minimum goals in contrast to the previous plan with minimum-maximum ranges. The revised minimum minority contracting goals set forth in contract documents are: 15% for architectural and engineering, 17% for construction, 13% for manufacturing and equipment, 14% for professional services, and 6% for service and supply. The new EEO policy, however, requires that a specific named commitment must be made at the time of bid submittal for construction and procurement type contracts. The joint venture role in the EEO area, other than internal goals and commitments has been only to support the MARTA effort.

Wrap-Up Insurance

All MARTA contracts are covered by an overall wrap-up insurance policy. Coverage includes: general liability (personal injury and property damage), workmen's compensation, property insurance (including builder's all-risk, errors and omissions, business interruptions), and safety program supervision.

This program was initially established when rail construction started and was reaffirmed in early 1979 to be a continuing program so long as MARTA construction volume exceeded $75,000,000 under contract. Wrap-up insurance has been widely debated in articles by Novell, and others (3). Its merits will not be debated here other than to summarize MARTA's view.

Wrap-Up Insurance Advantages

1. Saves cost (difficult to prove).
2. Provides uniform and well-qualified administration of the total insurance program.
3. Promotes a coordinated safety program.
4. Assures claims handling in a uniform fashion by a single staff element.
5. Provides controlled direction of preconstruction surveys.
6. Assures availability of insurance coverage even in a tight market and for those contractors who otherwise could not obtain it.

Wrap-Up Insurance Disadvantages

1. Contractor may not reduce bid price to reflect insurance savings.
2. Disrupts contractor's normal business relationship with his insurer.
3. Reduces incentive for contractor to run a safe job (MARTA wrap-up insurance does *not* include an incentive plan such as WMATA).
4. Covers marginal contractors by "Blind Underwriting."

In general, MARTA's experience has been reasonably good with a loss ratio of about 59% against a target of 40%. MARTA's lost time incident rates against the 1977 national average of 5.6 and a 1978 average of 6.2 are: 1976—9.0, 1977—8.1, 1978—5.4, 1979—5.0 (through November).

Due to an excessive number of incidents in which public utilities have been damaged, the deductible for such damages has been increased to $5,000 for the first occurrence, $10,000 for the second, and $15,000 for each subsequent incident under each contract. The effectiveness of the "incentive" to the contractor from these new deductibles has not yet been established. The joint venture is responsible to MARTA for jobsite monitoring of the contractor's safety programs.

Summary

In reviewing the many years of the joint venture imvolvement in the MARTA project a summary reflection would indicate that:

1. The coordinated resources of MARTA and the joint venture were required to achieve every major project milestone.
2. With the clear objective of achieving designated revenue service dates, all other considerations became secondary.
3. Major organizational and staff change was a natural part of the project life cycle.
4. Goal achievement required a totally dedicated and single purpose staff on the part of MARTA and the joint venture.
5. Each project like the MARTA system, and frequently each phase of a given project, is unique in itself with the only common denominators being challenge and risk.
6. Any new major project starting up from a zero base would make a aserious error to ignore the experience of other agencies developing comparable systems.

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MANAGING PUBLIC SUPERPROJECTS: THE TEAM APPROACH[a]

By Joel Wesselman,[1] William J. Katz,[2] M. ASCE, and Charles V. Gibbs,[3] M. ASCE

INTRODUCTION

The complexities of supervising giant public works projects have increased substantially in recent years. Many projects, though well-planned, have suffered from poor or disorganized management. The result has been a rash of late, over-budget, and technically unsound projects that have failed to meet the public interest, and challenge the abilities of the engineers that designed them.

The problem has not gotten better. In the words of Frank P. Moolin, Jr., project manager of the $7 billion trans-Alaskan oil pipeline (5):

> I wish that I could report that the ability to cost-effectively manage giant projects has significantly improved in the past two years . . . unfortunately, I believe the opposite situation is closer to the truth.

Those words, while harsh, are in many ways true. Little has been done by the engineering profession to document the successes or face up to the failures of past superprojects. In order for management techniques to be perfected, this body of knowledge needs to be developed and analyzed.

Since the advent of the Milwaukee Metropolitan Sewerage District's (MMSD) $1.6 billion Water Pollution Abatement Program in 1977, MMSD has operated

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under a program management concept. Program management basically involves a team approach, with a public agency's staff working in close cooperation with outside consultants. Although the project will continue through 1989, the past 2-1/2 yr have been especially critical because they have encompassed the important tasks of organizational startup, much of the facilities planning, and the designing of arrangements to facilitate the transitions from project design to construction.

The Milwaukee project has given the writers an opportunity to examine the effectiveness of the program management concept in great detail. The observations contained in this paper are meant to be instructive to others in the facility design field who confront choices about how to manage complex capital projects. It is additionally hoped that this paper will serve as a catalyst for further reports such as this, and the development of improved public management techniques.

Specifically, this paper has been designed to define the program management concept and demonstrate its principal features and drawbacks. In addition, based on the writers' experience, program management techniques will be evaluated with particular emphasis placed on efficiency, timeliness, contractor accountability, and client relations.

Program Management—Definition

A typical public works project for a large city is a long-term endeavor characterized by technical design complexity and plagued by the rigors of inflation. Over time, it exerts changing manpower demands, calling for different numbers and types of professionals as the project moves from planning to design to construction. Public agencies cannot easily provide the staffing flexibility to respond to these varying requirements. Yet, to ward off the effects of inflation, it is important that they prosecute the work vigorously and efficiently.

Traditionally, public agencies in most medium-sized and some large municipalities have managed and performed all work associated with major projects. Such agencies are legally and politically accountable for the provision of public services and facilities. Regardless of management technique, this accountability can never be compromised or surrendered.

Under program management, the public agency delegates the authority for management and technical services to contractors, who then operate under close monitoring by agency personnel. In this way, the public agency is able to retain complete accountability while at the same time relieving itself of the burdens of managing and performing the technical project work.

To borrow from A. H. Gaede, Jr., and Stanley D. Bynum, the following factors make a program management approach the most reasonable: a large, long duration project; a desire, or requirement, for fixed-price contracts; and a desire, or requirement, to begin construction *prior* to completion of the overall design (2).

The overall rationale for program management is that it results in lower project costs than if all work were performed by the public agency. Contractor staffing is temporary and highly flexible, permitting the use of specialized expertise only when needed, whereas the staffing level of a public agency tends to become fixed after it is geared up for a specific project. Program management also centralizes project guidance, relieving the public agency of the responsibility

for keeping track of numerous contractors working on separate pieces of the project. This centralization also results in increased planning and organization efficiency. Combined, these factors help to save both time and money, and serve to soften the effects of inflation over the life of a project.

It is important to distinguish between program and construction management. Program management is concerned with all stages and all elements in a program, beginning with the initial planning. Construction management, on the other hand, has to do only with the timely and efficient design, approval and construction of *individual* elements of a public works program. The two management concepts are applied similarly, but on different levels. Construction management might be most easily understood as a part or subset of program management. The construction management approach will be discussed in greater detail later in this paper.

Although the management techniques were not named as such, program and construction management procedures have proved successful on other large water pollution projects now underway in Sacramento and completed in the 1960s in St. Louis, Seattle, and San Diego. Today's most complex public works projects in the field of transportation—San Francisco's Bay Area Rapid Transit (BART), Atlanta's Metropolitan Atlanta Rapid Transit Authority (MARTA), and Washington's Metro—have all used program management approaches similar to the one we are now using in Milwaukee.

Program Management—Client/Consultant Relationships

It is becoming more evident to program planners of all kinds that there is much more to a successful project than meeting the original schedule, budget, and technical requirements. As a matter of fact, a recent survey of project managers showed that adequate cost and schedule performance were not included in a list of 23 project management characteristics significantly related to success as perceived by owners. Further, cost and schedule performance were not included in the list of 10 project management characteristics found to be linearly related to both perceived success and failure (1).

What then did characterize "success"? According to the survey, early establishment of strong working relationships, good communications, commitment and enthusiasm, and adequate goal establishment and agreement were among the most important characteristics of "successful" projects.

These results and our experiences in Milwaukee underscore the need for a good consultant and client relationship to be established in the early stages of a project using program management techniques. One of the first steps to be taken involves setting up agreed-upon roles and responsibilities for both the client and consultants involved. This definition of roles and responsibilities serves to clear the air of mutual concern and is the initial and most vital step in the development of an organized and efficient working relationship.

As an example, the following generalized responsibilities would be drafted among others more specific to each individual project for the client of a client/consultant team:

1. Set policy for the program and monitor the activities of the consultants to ensure their compliance.

2. Monitor consultant activities to ensure that technical, cost and schedule objectives are met.
3. Monitor consultant activities to ensure compliance with agency regulations and appropriate state and Federal agencies.
4. Award all construction contracts and monitor consultant activities to ensure compliance with all contract provisions. Take responsibility for contract and grant administration including grant applications, contract terms and conditions, funding and payments.

The consultant half of the client/consultant team would be in turn responsible for the following:

> Management (direction, monitoring and control) of all activities of the program not retained by the agency including program planning, facilities planning, design, cost and schedule control, quality control, and construction management.

Notice the significant usage of words like "monitor" (as applied to the client) and "manage" (applied to the consultant).

In addition to the value of getting both sides involved with this process, early definition of respective roles and responsibilities can serve a further, and just as important, purpose: public understanding. It is often difficult for the public to understand why the cost of so many "consultants" has been suddenly added to their tax rolls. A document clearly spelling out the responsibilities of both the client and consultants can help to clear up whatever misconceptions exist.

Other ways to build strong client/consultant relations include the establishment of:

1. Well-defined success criteria.
2. Mechanisms for frequent feedback from both consultant and client concerning each other's performance.
3. Short and informal lines of communication.
4. Adequate and agreed-upon control techniques.
5. Mutual participation in setting schedules and budgets.
6. A strong understanding that both the agency, and the consultants are working toward the same end.

In Milwaukee, a great deal of effort has been put into the development of these kinds of management tools, and the effective facilitation of a sound client/consultant relationship. We have found that one of the keys to project success is the *confidence* that the agency has in its consultants. This confidence must be earned through the consultants' commitment to the project and the client's overall objectives. One of the major reasons that projects of any size using program management fail is because of competition between client and consultant staff. Lack of confidence and competition are very much related—they are both based on weak client/consultant ties.

To combat these forces and further successfully organize the program in Milwaukee, we developed a program delivery plan (PDP), or "management

roadmap" as Jenes and Stroope of our staff labeled it in their paper (4), "Day-to-Day Management of Large Engineering Projects and Consortiums." This roadmap has become the basis of direction for our entire project, and, through built-in mechanisms, serves to strengthen the bond of trust and commitment between MMSD, and its consulting team.

The PDP is a strategic plan that outlines how the program is to be accomplished. The larger the program, the more specific and formal the delivery plan should be.

This kind of orientation does not stop at the program level. Each *project* within the program is organized in a very similar way. Project delivery analyses are prepared by project heads as detailed, agreed-upon client/consultant check-offs of project elements such as needed resources, cost estimates and scheduling requirements.

As indicated previously, communication is one of the biggest keys to successful project completion. Through communication comes understanding, and through understanding comes mutual support. To this end, we have established the following communication channels:

1. A strategic planning executive committee (SPEC) made up of the Executive Director and Director of Technical Services of MMSD and the Program Manager of the Program Management Office (the three writers of this paper). The SPEC meets when needed to approve program policy objectives and any changes that have been or may be proposed. Only the SPEC has the power to do so. Any proposal changes are judged by the SPEC and measured against pre-established baselines of *cost, schedule,* and *scope* (an extension of the configuration management concept touched upon earlier). It is through this process that individual actions are kept from negatively affecting a project's outcome. The "big picture" of the project's overall objectives is kept in perspective in this fashion. The added exchange of communication among these highest level personnel also results in better cooperation and understanding—both essential to effective project leadership.
2. A program coordinating committee (PCC) made up of senior management staff of both the MMSD and PMO. The PCC meets approximately once a month to discuss current issues and the status of individual projects and agree on priorities. The work agreement should not be passed over too lightly here. It is through committees like this that we've been able to keep the client/consultant team unified behind a program of up-front and mutually-agreed-upon objectives. Questions and concerns are encouraged. It is only in this way that a long-term working relationship can be developed.
3. A close program manager (PM)/program administrator (PA) team concept. At the working level, the PM/PA team is vital to both project and program success. The PM (consultant representative) and PA (agency representative) work together on projects and are responsible for the successful completion and constant monitoring of all work involved.

To better train both PAs and PMs, a series of workshops has been set up. In the workshops, PMs and PAs are presented programs on topics such as scheduling, cost-estimating, design management, field services and a variety of other subjects. The overall goal of the workshop program is to strengthen

the PM/PA bond. This bond will have lasting benefits throughout the duration of any project.

As we have tried to make clear, understanding is one of the main factors in building confidence and support. Knowing this, other mechanisms have also been set up to build understanding and help expedite the program. For example, the MMSD takes pains to reinforce its decisions through its commission, or what would otherwise be known as a policy board. In this way all activities are reviewed and committed to, and everyone becomes a part of the final decision. Especially in the case of superprojects, this is an essential arrangement.

Also in Milwaukee, we have set up a Grants Policy Committee (GPC) made up of the Environmental Protection Agency, State Department of Natural Resources, Regional Planning Commission, PMO and MMSD representatives. Senior staff members of the MMDS program management staff (consultants) have also been given the authority to work directly with the various grant agencies. The GPC meets monthly to discuss program status and to communicate immediate project needs to the grant agencies. In a "fast-tracked" project, close coordination must exist between the owner and grant agencies so that sufficient funding may be obtained at the critical times in the project. Without a close relationship, project schedules can be easily held up due to the lack of adequate outside resources.

Before closing this section, one additional point must be made. Above all, program management requires flexibility from both the client and consultant as the project moves from one stage to the next. There must be an effective give and take on both sides. This must be a clear and understood commitment for the client, as well as consultant. As program needs change, the client organization must be able to restructure so it can continue to monitor and offer the program the quick decision making it demands. Centralized management decision making, which has proven so valuable in expediting the work of facilities planning, is not well suited for design and construction, where decentralized management is more desirable. It is not an easy balance. These constant changes underscore our previous comments concerning the importance of program understanding within all levels of the organization.

Program Management Features/Benefits

One of the most important reasons for applying the program management concept is the reduction of lead time for the design of large projects. Elaborate government regulations, lengthy review processes, inadequate staffing, and the need to significantly involve the public in the planning process are among the factors that have continually plagued large projects and kept them from being completed on schedule.

Under program management, initial construction begins long before the project's design phase is completed. This approach, commonly referred to as "fast-tracking," allows for accelerated procedures and a great savings in both design and construction time. It is anticipated that this accelerated approach, together with concentrated construction management, will save the MMSD approx 2-1/2 yr of design time and more than 3 yr of construction time. Current estimates of the value of this time saving is approx $390,000,000 in *local funds*.

A risk and trade-off that must be understood and accepted before a program

management strategy is undertaken is that study and review of the entire project design cannot be done prior to the start of construction. This is potentially dangerous if the necessary controls are not made an integral part of the overall management program.

As we mentioned previously, one of the ways that proper control can be exerted is through the employment of configuration management techniques in the program's decision making process. Configuration management requires that each proposed program change be evaluated to establish whether the merits of the change are worth the cost and time it entails (3). Configuration management establishes formal baselines during a project's life cycle that cannot be crossed until the previous phase has been completely resolved and the documents constituting each baselines are verified as complete and accurate. In this way, a program can remain "fast-tracked" with a reasonable guarantee it won't be side-tracked from its original schedule and set of objectives. In addition to accelerated procedures, program management also provides for the following items.

Single Source Technical Responsibility.—For major programs involving several components of diverse geographical location and scope, a program management approach provides a central place for the owner, as well as the public and regulatory agencies to receive and make technical and policy input and see their effect on the total effort.

Consultant Staffing Flexibility.—Expertise can be provided as needed, including the use of nationally and regionally recognized experts. This expertise is injected into the process only when it will prove more beneficial, freeing the project from the long-term costs that would be associated with the level of employment of permanent personnel at the same level.

Unified Program Management.—Technical considerations are assessed centrally, rather than by separate consultants handling individual projects. Central management also fixes responsibility for quality control and enables systems and services to be standardized program-wide.

Packaging of Design and Construction.—The total program is constantly reviewed for constructability. Design packages are assembled which reflect resource and construction needs in all areas of the program rather than only the needs of individual facilities reviewed in isolation. These design packages optimize scheduling, cash flow, resource availability and owner-managed construction opportunities.

Monitoring and Coordination of Design/Construction.—Work being performed on design packages which "cut across" facilities must be internally monitored and managed to ensure coordination among designs. The individual responsible for this function is the construction manager, to whom the designer and contract manager report.

Effective Community Involvement.—Contact with interest groups and the general public can be maintained through a Community Involvement Program (CIP) directed by the agency, and carried out by consultant community involvement specialists. The CIP consists of a wide variety of communications activities, citizens' advisory groups, and other arrangements, to permit citizen participation in the evaluation and selection of project alternatives.

As indicated earlier, the classic construction management approach can and should be used in conjunction with program management. Under construction

management, a single individual is given the responsibility for project delivery. This person must coordinate the work of design engineers who may not work within the program management office—indeed, they may be located elsewhere in the country. This places a premium on this individual's ability to review the design work and monitor progress with speed, and an awareness of the design-construction interface. He or she is assisted in this review effort by consultant quality control teams.

The construction manager must also expedite review/approval procedures and then supervise the bidding, and analysis and award process. Finally, he or she must supervise the requisite field activities related to construction. The construction manager's project delivery analysis must anticipate all these responsibilities if the overall program delivery is to work efficiently.

Program Management—Problems to Avoid

Experience has shown program management is not a push-button concept. There are no one-size-fits-all solutions. Each program must be specifically tailored to the project involved.

There are some problems that should be universally avoided, however. As experienced by the MMSD in its first 2-1/2 yr of operation, these difficulties included the following difficulties.

Middle-Management Communication Problems.—Misunderstandings and lapses of communication are traditional and common in client/consultant relations on large, complex projects. Expanded orientation programs and more intensive management training can help to rectify this problem along with the formation of streamlined communications channels.

Client Reorganization.—Programs must be reorganized as they progress through the phases of planning, design and construction. As with any reorganizations, communication links change and thus, the owner or client must also reorganize or realine responsibilities to match the program change. Every effort should be made by both the client and consultants to make this needed realinement as smooth as possible.

Public Perceptions of Initial Program Costs.—The "fast-tracking" of a major project calls for a heavy front-end investment in software but produces little or no visible effect in the community. This is difficult for the public to understand, and in the absence of an effective public information program, it is easy for the taxpayers to believe that their money is being spent with no purpose.

Paperwork Problems.—The "fast-tracking" of grant applications generates a substantial amount of paperwork with which all of us must deal. The paperwork imposes an extra load not only on the client and its consultants, but also on the staffs of the granting agencies who must review and approve applications.

Conclusions

Client and Consultant Relations.—The success of the program management concept is largely people dependent. Human relations as well as institutional relations are very important. Any public agency which enters into a large-scale program management arrangement needs to give serious attention to this fact. An extra effort must be made to ensure that public agency staff members are

well-informed about program management and are seriously committed to it. This is not something that can be achieved by a one-time briefing. It requires constant and effective communications, and of course it also requires that the line between client responsibilities, and consultant responsibilities be clearly and specifically drawn.

Relations with Reviewing Agencies.—Program management must function in the context of the legislative, regulatory, and procedural requirements that govern almost every aspect of a program. It should be noted that good relations with these agencies should be maintained in an effort to gain their cooperation in the matching of funding and program elements, "fast-tracking" of review and approvals, and other procedural innovations.

Relations with Public.—The program management concept can be easily misunderstood. If it hasn't been adequately explained to the public, it can look suspicious. Critics may claim that the public agency has abdicated its responsibility by handing over too much power to a team of private consultants. Questions of accountability may arise. Concerned citizens and officials may wonder whether the public interest is being protected—especially during the first year or so of work, when no tangible results are visible, but substantial amounts of money are being spent.

Public debate needs to center on the hard choices—what types of facilities are needed, what methods of construction will be used, what financing measures will be employed. These are the choices program planners need the public to help them make.

Efficiency and Cost-Effectiveness.—The consolidation of effort inherent in the program management concept is simply a way to expedite procedures, complete the components of a project on time, ward off the impact of inflation, and accomplish the project's objectives. With the public agency maintaining administrative control through adequate technical and fiscal auditing, the requirements of accountability and functional efficiency can both be met.

Program management is more efficient and cost-effective than conventional methods of project guidance. It results in lower overall project costs. It may result in additional professional fees because of the intensified levels of management required, but these costs are more than compensated by lowered construction costs. Make no mistake—program management demands a great deal from the public agency officials who must supervise it. But, if those officials do their jobs right, program management can yield indisputable benefits to the community. Experience has convinced us that program management is a process of very great utility for public sector projects. We commend it as an approach that is applicable to other major public projects that confront severe time constraints or where the potential for lowered total costs outweigh the additional professional services required, or both. This will almost always be true for the large public projects.

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BOSTON'S SOUTHWEST CORRIDOR PROJECT[a]

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INTRODUCTION

By almost any measure, the Southwest Corridor Project is immense. With an estimated construction cost of over $480,000,000, the entire project will require a total public investment of approx $670,000,000. It is estimated that the project will provide approx 32,300 construction jobs and it will result in the creation of an estimated 10,000–12,500 permanent jobs. More than 30 design and consulting firms are involved in the project which is estimated to require over 1,000,000 man-hours of design effort. From its beginnings, it has been recognized that the project is not only a challenging engineering assignment, but a very demanding political issue as well. The magnitude of community participation and social issues in every phase of the design has required working relationships, and processes and a level of effort unlike any undertaken before. It seems likely that all future major public works projects will require similar organization and approaches as those developed for this project if they are to be responsive to the multitude of interests and goals established by the many and varied participants.

In order to properly understand the development of the Southwest Corridor Project from the standpoint of project management, it is important to view the management organization and mechanisms with a perspective of the project's historical development.

OVERVIEW

The project site is located in the southwest quadrant of Boston, in an area extending from the downtown area at Berkeley Street, along an existing railroad

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right-of-way to the Forest Hills section. The area is characterized by several existing transportation modes, which include a system of rapid transit facilities, a number of public and privately operated bus routes, several arterial streets, major rail facilities which serve southwest commuters and CONRAIL facilities passing through the area.

The existing elevated Orange Line of the Massachusetts Bay Transportation Authority (MBTA) built in the early 1900s provides rapid transit service along Washington Street approx 4.7 miles from downtown Boston to Forest Hills. The elevated steel structure is antiquated, noisy, and has a blighting effect on the area through which it passes. Light-rail service in the Corridor consists of the Green Line which is largely an in-street operation.

Four commuter rail routes have operated through the Corridor to reach Back Bay and South Station on the Shore Line. AMTRAK services are available on the CONRAIL tracks between Washington, New York, Providence, and Boston, stopping at Route 128 station enroute to Back Bay and South Station in downtown Boston. The northern portion of the existing rail line is located in an open depression, and then emerges on a substantial embankment which passes through the Roxbury and Jamaica Plain sections of Boston. Communities on both sides of the embankment are linked by narrow underpasses.

There is an extensive network of surface bus routes which serve the Southwest Corridor area. The bus network focuses heavily on existing rapid transit, and bus routes and schedules have been closely coordinated with rapid transit schedules.

Major Project Elements.—The Southwest Corridor Project as ultimately developed is multimodal in nature consisting of facilities for rapid transit, interstate railroad, commuter railroad, and an arterial street.

Rail facilities for the project will include two tracks for the relocated Orange Line, three tracks for AMTRAK and commuter railroad operations, and eight transit stations, three of which will also be station stops for commuter rail service. The limits of proposed transit and railroad improvements are from the terminus of the South Cove Tunnel Project to a point southwest of the existing Forest Hills station. The Orange Line tracks will be about 2 ft–3 ft higher than the railroad tracks. New bridges are required at 22 locations.

An integral component of the proposed transportation improvements to be implemented within the Southwest Corridor is the provision of a regional Green Belt consisting of bike paths, landscaping, pedestrian trails, and lighting extending from Ruggles Street south to the Arborway in the vicinity of Forest Hills. The proposed Green Belt will be located adjacent to the transit/railroad/arterial street right-of-way and will vary in width depending upon land availability.

Project Organization

In an effort to limit the number of engineering and architectural contracts and associated technical coordination problems, the client determined that the project design effort should be broken into three geographical sections.

Each section includes not only engineering but architecture for two or three stations as well. In order to encourage the design team concept, the MBTA proposed to award one design contract for each section, and each section designer was required to have a separate architect for the design of each station within

a section. Each section design contract includes responsibility for all engineering and architectural work within the geographical limits of the section with the exception of specialized system-wide elements of the project. The responsibility for general coordination of all engineering and architecture belongs to the MBTAs project manager; however, in order to respond to the technical coordination requirements and at the points of design interface, technical coordination was assigned to one of the section designers. In addition, the design engineer team selected for this technical coordination effort is responsible for the initial layout and final coordination of transit, railroad and highway alinement and profiles for the entire project as well as urban design and landscape architecture.

Role of Client.—The MBTA project manager, Anthony Pangaro, is the principal point of contact between the section designers and the MBTA, and is the designee of the MBTA in all communications with other agencies of government involved in the execution of work required by the contract. Matters of policy and contractual concerns are brought directly to the attention of the project manager who issues instructions to the section designers, as necessary.

Technical material and matters requiring coordination between the section designer, other section designers, or the coordinating consultant are communicated directly by and between these parties, with a copy of all correspondence and information to the project manager. Contractual matters are transmitted directly through the project manager.

The project manager also approves the coordinating consultant's procedures establishing the method of communication between the section designer and other section designers, the coordinating consultant and all other agencies. Final resolution of any disagreement on technical matters between the section designer and the coordinating consultant are also the responsibility of the project manager.

The section designer is required to assist the project manager in the presentation of information to other departments within the MBTA to resolve conflicts between MBTA standards and project area conditions (neighborhood goals, physical constraints, city of Boston or other governmental standards, etc.).

Role of Coordinating Consultant.—To provide continuity of design, the coordinating consultant is charged with developing the graphic alinement and profile for the entire project. The alinement and profile is based on the transit and railroad clearance envelope, preliminary geotechnical analyses, and other criteria developed by the coordinating consultant utilizing preliminary cross street layouts, bridge depths and other site-specific data provided by the section designers and input from the MBTA and other agencies. The alinement and profile information is furnished to the section designers who are required to review the information and verify its accuracy.

The coordinating consultant, utilizing input from the section designer, establishes engineering and architectural design criteria and standards for use throughout the project. These documents are subject to an ongoing process of expansion and updating.

The coordinating consultant also establishes system-wide requirements for the project, by reviewing design development by the section designers to assure meeting the objectives of the MBTA in terms of performance, cost and schedule, and coordinating the project through design, construction, and system startup. The section designers are required to prepare architectural and engineering designs within the limits of each section, package the designs into construction contracts,

and provide architectural and engineering services during construction of those elements.

Engineering subconsultants are retained by the coordinating consultant to assist in the design development of elements which require system-wide uniformity or continuity. These elements include control surveying, geotechnical engineering, acoustical and vibration engineering, corrosion control, train (railroad and transit) operations, track work (railroad and transit), transit traction power design, transit signals and communications, fare collection systems, fire emergency provisions, escalators/elevators, and other system-wide facilities.

Architectural subconsultants are also retained by the coordinating consultant to assist in the design development of elements which require system-wide uniformity or continuity. These elements include station architectural programs, corridor-wide concepts for landscape architecture and urban design, community participation coordination, joint land development concepts, station signing and graphics, lighting, and other elements which require system-wide continuity.

The coordinating consultant has also established initial and continuing coordination procedures with the MBTA, community and neighborhood groups, agencies and other interested organizations or individuals, and coordinates the format and process for public reviews, newsletters, and other information for the community. The coordinating consultant works with the MBTA, and the section designers to establish a process of interface between the community and the architectural/engineering activities of the section designer. Each section designer is required to prepare all presentations and related graphical material for design elements within the section (excluding system-wide elements for which the coordinating consultant has responsibility) and present such information at community participation meetings.

Section III Organization

Frequently, large projects have suffered from a lack of cooperative team effort. Oftentimes, the prime consultant, the subconsultants, and even the client have assumed independent roles which tend toward serving their particular interest. Such positions, however, ultimately result in harm to the project, and eventually, to the parties themselves. In its role, the prime consultant and manager of the design team must create a spirit of team effort. This requires a strong management team and an effective project control system which provides the basis for timely managerial actions.

Design Team.—On October 18, 1976, the design team was notified that they had been selected as section designers for section III of the Southwest Corridor Project. Firms were selected to perform the functions indicated, provided that agreements could be reached with the designated firms on subcontract terms and conditions satisfactory to the prime consultants and the MBTA: (1) Architects for Forest Forest Hills station and parking garage; (2) urban design; (3) Architects for Green Street station; (4) architects for Boylston Street station; (5) landscape architecture; (6) geotechnical engineering; (7) survey; and (8) noise and vibration engineering.

The prime consultant entered into all agreements and contracts for the conduct of the work. All principal firms of the section III design team participating in the project subcontracted with the prime consultant who is responsible for

the direction, and coordination of all activities. When managing a design team, substantial in-house experience in all significant disciplines of the work proposed for subcontracting is important for maintaining a significant scope of technical understanding of all aspects. The working relation between the prime consultant and the subconsultants, and among the subconsultants are governed by the subcontract agreements. Management direction and control of all aspects of the project, including subconsultant performance and relations, are vested in the section project manager. Emphasis has been placed on adequate, clear interdisciplinary and intercompany communications and liaison.

The section project manager is the individual designated by the contract partner to be responsible for the direction and coordination of all efforts on the project. Other managerial functions which are also the responsibility of the section project manager include the planning of required efforts, organizing those efforts to accomplish the work, and controlling the various aspects of the work so that the project can be completed with the proper amount of available resources.

The section project manager has the responsibility for preparing the project budget, and for promptly preparing revisions whenever estimated fees or other conditions change. Furthermore, he is responsible for ensuring that monthly progress information is properly reported to the firm's central administrative staff, and for initiating appropriate changes in the cost control system whenever extra work items or supplemental agreements are accepted by the client.

Commencing with a relatively detailed draft scope of work contained in the Request for Proposals (RFP), and, proceeding through a series of joint consultant meetings as well as individual negotiating sessions with the MBTA, a scope of work was developed for the section designers. After the contract scope of work had been resolved, each of the station architects subcontracts were tailored, article by article, to suit the particular situation, and provisions were added as necessary. It was noted that there were many conditions in the prime consultant agreement with the client that would require the assistance or representation of the subconsultants and it was felt that simple reference to the prime contract provisions in the subconsultant agreements would not be sufficiently clear to anyone to what degree the commitment was intended. There is the tendency (as well as the fact) to assume that there is a certain degree of insulation from the prime contract.

The five other (smaller) subcontracts followed the same general format as the subcontracts for the stations except that a considerable amount of text could be cut to suit the magnitude and nature of the work.

Costs and Schedules.—A control estimate of design costs to be incurred for each phase under the contract, was prepared and submitted to the MBTA for approval. This control estimate was in the form established by the MBTA and consisted of a list of major work items and the estimated cost of services for each such item broken down by man-hours, labor categories and wage rates. This control estimate is utilized during the performance of the services for the purpose of monitoring and controlling the cost of the services.

Under the terms of the contract, bar chart diagrams for performance of services were also submitted to the MBTA for approval. The diagrams consist of a graphic representation of all major activities necessary for the performance of the design work. A separate diagram was prepared for the preparation of each construction contract. For each activity, the following data was provided:

(1) Description; (2) estimated duration; (3) estimated manpower requirement; and (4) cross-reference to control estimate of design costs. The relationship of each activity to its predecessor and successor activities were also shown.

Progress Reports.—Monthly progress reports are submitted to the coordinating consultant, by the 20th day of each month for the said month. The monthly progress report is divided into the following parts.

Narrative.—This part includes a brief narrative discussion of all activities in progress during the month. Coordination with other section designers, governmental agencies and utilities are covered. Activities by others over which the section designer has no control but which bear on design progress are discussed. In addition, all assumptions underlying the design for which verification is required, and all activities or approvals by the MBTA, the coordinating consultant, or others necessary to design progress are enumerated and discussed.

Schedule and Cost Report.—This part is prepared in the format approved by the MBTA based on the control estimate of design costs, and includes the following:

1. The date upon which all activities in each bar chart were begun or completed.
2. For activities in progress, the estimated number of workdays required to complete.
3. Changes in bar chart logic deemed necessary by the section designer. These changes are subject to the approval of the MBTA.
4. Estimated cost of services for each work item in the control estimate. The estimated cost includes all amounts actually invoiced, plus estimated costs through the end of the reporting period.
5. An estimate of the cost to complete the remaining services for each work item in the control estimate.

If the sum of the amounts of (1) and (5) in the preceding format for any work item in the control estimate exceeds the total amount established in the approved control estimate for the work item, the section designer is required to include a full explanation of the reasons for such anticipated overrun, and a description of the steps that can be taken to permit completion of all services within the total approved estimated cost.

Actions Required by Others.—This part consists of comprehensive statements individually enumerating specific actions which are required by others to complete the design and without which actual design or construction cannot be executed on schedule. Examples of typical actions include approvals from public or private agencies for traffic detours and staging, property acquisition and easements, etc. In cases where section designers for adjacent sections are involved, the statements include interface coordination assumptions upon which the design is based.

Internal Cost Control System

The progress of design is monitored continuously by a management control staff. Estimates of progress were obtained for all work tasks from both in-house departments and the subconsultants, utilizing special reporting forms and procedures that were prepared to facilitate the estimating and reporting procedure.

These estimates were reviewed for accuracy and completeness, and all apparent discrepancies were resolved. The individual estimates of progress for each work task serves as the basis for input to the management scheduling and control system.

Utilizing an in-house data processing center, estimated progress is compared to scheduled progress. The effect on project completion of delays in individual work tasks, or unforeseen occurrences, are determined and analyzed as they occur. Alternative courses of action that will return the project to schedule are developed and analyzed.

A cost control system is utilized to provide all levels of production management with sufficient, timely data so that managerial decisions concerning control of the various aspects of the design project can be made. The cost control system is a part of a package of systems providing management information. The system follows the basic control philosophy of establishing a budget which outlines an estimate of costs of performing the work, then comparing actual costs expended against the budget as work progresses.

Recognizing that many projects change or develop in ways not anticipated at the time the original input is submitted, the system has been designed to provide flexibility, allowing additions, changes, or deletions of data on file. This feature, however, can lead to the problem of incorrect data in the system.

Actual costs of performing the work come from the payroll and expense portions of the central accounting system. Job progress is supplied by supervisors who have the assigned responsibility of performing specific tasks required to accomplish the project. From this input, the system generates cost control reports for the various managerial levels.

The job budget report is a print out of all budgetary information. It provides the section project manager with the job identification information, and job budget data that have been input to the cost control system. The budget reflects the plan for accomplishing the project in accordance with the contract, and it enumerates anticipated resources in man-hours and costs to be expended for successful completion, and also presents a picture of the organizational requirements, i.e., work to be done in other offices, assignment of responsibility for accomplishment of tasks.

The task assignment report provides information to persons assigned specific task assignment responsibilities. The purpose of the task assignment report is to communicate the status of assigned tasks to the persons responsible for their performance. The individuals assigned responsibility for tasks or budget items can quickly ascertain the status of expenditures, both on a current and job-to-date basis, and the percent complete on all active assignments. A comparison of the percent complete as of this period with the job-to-date percent of budget costs expended, yields areas where attention should be directed when a significant discrepancy between these values exists. Each month the percent complete values are reviewed to ensure correctness in accordance with values submitted via the job progress input form.

Project reports are the most important output of the system for control purposes. Following the outline of the budgets, these reports not only compare actual expenditures against budgeted man-hours and costs, but also project total expenditures based on the percentage reported complete to forecast budgetary overruns and underruns.

The purpose of the project report is to provide accurate, concise, and timely financial information on which to base decisions concerning control of costs. It is considered the principal tool for managerial cost control purposes. A review of man-hours and dollars spent along with percentage of budgeted man-hours and dollars quickly gives an indication of the job-to-date status of the project with changes in the percentage reported complete. If any mistakes are discovered, the person responsible for the task is contacted to ensure that the following month's report accurately reflects progress on the work. Particular attention is also directed toward those tasks where an anticipated budgetary overrun is indicated. The percentage reported or calculated complete, completion dates and man-hours to complete, allow monitoring of CPM networks, bar charts, or other control diagrams that have been established for the project, and are used for scheduling purposes to update progress reports.

The system is viewed as a managerial tool, which assists in accomplishing the managerial functions. Budget preparation is an integral part of planning, and reflects the resources and organization necessary for the project. Output reports from the system enhance coordination of efforts and is regarded as the primary tool for control purposes.

Conclusion

The experience of the design team for section III of the MBTAs Southwest Corridor Project to date, we feel, has demonstrated, that an organization can be established that will provide a reasonably efficient mechanism to accomplish the design of a major public works project and still be very responsive to the needs and desires of the communities affected and achieve various goals of both the design team and the client agency.

The primary goal of the design team is, of course, to develop uniquely effective and innovative design for the project on schedule, and within the established fee. This goal is being achieved by assembling, organizing, and monitoring a team of independent professional firms specially qualified and suited to be responsive to particular elements of the project. Effective direction of the team is achieved by establishing an effective channel of communication through periodic coordination meetings and design review meetings. Control of the team is achieved by scheduled monthly progress reports and design progress reviews aimed at avoiding duplication of design efforts and preventing conflicts at the interfacing of the various project elements.

The goals of the client-agency are also being achieved through the utilization of the design team concept. The project is providing business opportunity for the numerous local professional firms directly involved in the design of the project, as well as providing significant opportunities for minority business through goals established for the project. The design team has been responsive to the numerous needs and desires of the communities and the public by providing considerable job opportunities, including a special educational training program directed to the youth of the affected communities. Assigning specially qualified firms to particular project elements has resulted in a high degree of responsiveness to the particular requirements of the various neighborhoods.

The ultimate result of this monumental effort should be an attractive and

effective mass transit facility, uniquely suited to the community through which it passes and serves. The project will result in a much improved neighborhood environment which will encourage revitalization and new development, with new job opportunities, and ultimately, an improved standard of living for a significant portion of the greater Boston community.

LET'S TEACH GEOLOGY TO THE CIVIL ENGINEER STUDENT

By Richard J. Proctor[1]

Engineering students in many universities are benefiting from a trend which should be expanded. They are encouraged to work part time and summers in industry where they learn first hand about practical or "real world" problems—often less of a technical nature than they suspected. The practical needs of a functioning organization or construction project expose the student to an awareness he/she cannot obtain in a classroom environment. To help bridge the gap between industry and academia, the writer suggests that universities encourage more industry professionals to lecture to engineering students.

The writer is a practicing engineering geologist who offers this opinion on the basis of more than 20 yr of work with civil engineers on large construction projects. A specific place where universities could improve the formal education of civil engineers, would be to require a course in Applied Geology or Engineering Geology. A large proportion of Civil Engineering (CE) graduates have had none, or only minimal, exposure to applied geology in our universities. Robert F. Legget (2), an engineer and a geologist, repeated this theme in his Thirteenth Terzaghi Lecture of ASCE:

> . . . a basic part of the training of *every* civil engineer must be an introduction to the science of geology, preferably in a manner that will illustrate the relevance of geology to civil engineering.

This theme was made more specific by Karl Terzaghi (5):

> I believe that a two-semester course combined with field trips fully serves its purpose provided that the course represents the combined efforts of a geologist who appreciates the requirements of engineers and an engineer

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who has learned from personal experience that geology is indispensable in the practice of his profession.

Dr. Richard Jahns, Dean of Earth Sciences, Stanford University, sees the problem thusly (1):

> . . . a legitimate frustration [is] shared by both engineers and geoscientists. It is a frustration nourished by real differences in their responsibilities, attitudes and methodologies. . . . Even for those fields of engineering and geosciences that are closely related and in which practitioners have common stakes, there are essential differences in available data, styles of investigation, and methods of problem solving.

Of course, it works both ways. A geology major that has a bent toward engineering should avail himself of appropriate engineering courses, such as Soil Mechanics and Foundations.

Relating to personal experience over the past few years, the writer has been a part-time visiting associate professor of geology at one of the top engineering schools in the country. The teaching assignment was a course in Engineering Geology, taught to stress the case history approach ("This is what failed, but what could have been done to prevent it?"). The course is an elective offered to students of both geology and CE. The writer was surprised to discover that a geology course still is not a requirement for the engineering degree at many universities. How can such graduates deal with "earthy" problems such as foundations, slope stability, and borrow material sources, when they are uncertain about the meaning of terms the geologist may discuss? Whether a site is underlain by "d.g." or river alluvium can make a significant difference in foundation treatment and costs, yet the two materials may look and feel similar. When the CE graduate reads "adverse schistosity" does he suspect future slides? Does "10% montmorillonite shale" signal swelling conditions to him? Does he realize that the Vaiont Dam and its foundation were excellent, but the reservior banks needed more investigation?

Acknowledged that it would be good to have more experienced professionals from industry teaching at our universities, a drawback is that most universities require a doctoral degree to teach. This rule inhibits many established and recognized professionals from contributing to the faculty team, because they went out into professional practice immediately after obtaining their Bachelor's degree. Many could probably allot enough time to share their acquired knowledge as adjunct or visiting professors if exceptions to the rule were encouraged.

Engineering professor Hans Liepmann (3) expressed his view thusly:

> The awareness of industrial needs and problems by an engineering faculty, which is obviously a crucial prerequisite, can be brought in differently. Mutual consulting—faculty in industry and industrial engineers in schools—seems to me a necessary requirement.

The only geology course taken in school by many engineers was the elementary Physical Geology. This can be more harmful than no geology at all, because the engineering student may come away from the class thinking to himself,

"Gosh, it's kind of interesting learning about fossils and volcanoes and minerals, but if this is geology, it's not very helpful to me." He is right that it is not very helpful, but he is unaware that this class is anything but a minute part of the geology spectrum. As Legget, Terzaghi, and Peck (4) suggested, a *relevant* geology course should be required of the CE student; preferably a course taught by a geologist with some practical experience outside of academia. The trouble is, he's a rare bird. As an illustration of how rare such a teacher is, only 66 universities in the United States have geology faculty who are members of the Association of Engineering Geologists (AEG); (the admission requirements of AEG call for a minimum of 3 yr practical experience working with registered civil engineers or with certified engineering geologists). Even so, most of these 66 universities do not offer a course in Engineering Geology or Applied Geology that is available to the engineering student. Clearly, this is an area where our universities need improvement.

This writer extends the challenge to deans and their faculties and to your alumni of practicing engineers and geologists to fill this gap in your quest for relevance and excellence. Specifically, establish a link with an experienced engineering geologist who is willing to teach. A letter to the AEG President or Executive Director should establish one or more local candidates.

As Robert Legget (2) urges:

> One of the greatest of all contributions that geotechnical engineers could render to their profession would be for them [us!] to do everything possible to render geology familiar and meaningful to all civil engineers.

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REPORTING AN EMPLOYER'S UNETHICAL ACTIONS: SHOULD WE? DO WE? WILL WE?[a]

By Thomas A. McCrate,[1] A. M. ASCE

Should we report the unethical actions of an employer? As individuals the answer must satisfy our personal conscience, as engineers the answer must satisfy the ASCE Code of Ethics.

In matters involving public health, safety, or welfare, the Code is dogmatic in its guidance. The first fundamental Canon (1) states "Engineers shall hold paramount the safety, health and welfare of the public in the performance of their professional duties." Furthermore, Canon 1.d (1) states "Engineers who have knowledge or reason to believe that another person or firm may be in violation of any of the provisions of Canon 1 shall present such information to the proper authority in writing and shall cooperate with the proper authority in furnishing such further information or assistance as may be required."

Should an engineer report an employer for unethical actions unrelated to public welfare? The Code of Ethics is not as explicit on this point. The second fundamental principle (1) tells us to serve our employers with fidelity. An effective employee/employer relationship requires a bond of trust and loyality. However, we cannot use our sense of loyality as an excuse to ignore unethical behavior. Canon 6.a (1) tells us that engineers shall not knowingly engage in business or professional practices of a fraudulent, dishonest, or unethical nature. To satisfy Canon 6.a, we must take whatever steps that may be necessary to correct the unethical situation. If it cannot be corrected, then I think we have a duty to terminate our relationship with the employer. However, I feel we must stop short of using information gained as an employee to discredit our employer.

I have expressed my opinions on what we should do as engineers, but what do engineers do? My suspicion is that engineers do not always report unethical

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conduct in situations where the Code of Ethics dictates that they should.

Too often we hear reports that toxic industrial chemicals are buried in our landfills and dumped into our sewers. Too often we hear reports that construction companies have used substandard materials in public projects. Too often we hear reports that industry chooses to ignore design defects in its products. Engineers have been given the talent and the knowledge necessary to judge when the public interest is in jeopardy. Too often this talent and knowledge is not used.

Perhaps engineers do not understand the responsibility placed on them by the Code of Ethics. As students it is rarely discussed and it has little application to the primarily technical duties of a young engineer. While lack of education may play a role in the unwillingness to report our employers, I think the primary reasons run much deeper and are much more difficult to rectify.

A noted psychologist, Maslow (2), developed a theory of the hierarchy of human needs. According to Maslow, this hierarchy includes hunger, security, affection, self-esteem, and finally self-fulfilling needs for justice and goodness. In general these needs must be fulfilled from the bottom up. People tend not to be concerned about justice when their life is endangered. There are certainly examples which contradict this hierarchy. Many men have died for principle and have gone hungry rather than beg. However, if taken as a general tendancy, I think the theory is valid.

If someone reports his employer for unethical behavior he is placing his personal need for justice before his basic hunger and affection needs. He risks hunger because he risks loss of employment and thus his livelihood. He risks the loss of affection because he has been disloyal to his associates.

In our wisdom it seems that we have established a Code of Ethics that runs contrary to human nature. What then is the prognosis for change? In reality it is probably not good for a fundamental change. However, if we do not try to change I don't think we deserve to be called professionals.

What can be done? If we turn again to Maslow's theory, the answer becomes evident. If we want justice and ethics to prevail we must teach ourselves and our young engineers to aspire to these values. Educationally, we must resist the temptation to eliminate the humanities from our engineering curricular. As a national society we should consider developing a monthly forum devoted to ethics. A format borrowed from a book entitled *Ethical Problems in Engineering* (3) might be effective. That format consists of the statement of a practical ethical problem and publishing the thoughts and views submitted by members. Developing such a forum would make our Code of Ethics more visible and perhaps we might learn that others share our sense of values.

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DISCUSSION

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It is suggested that potential discussers request a copy of the *ASCE Authors' Guide to the Publications of ASCE* for more detailed information on preparation and submission of manuscripts.

Responding to the Challenges of Engineering Practice[a]

Discussion by John M. Hayes,[2] F. ASCE

The author has described the critical challenges facing the engineering profession—facing both those in practice and those in education. The writer wishes to discuss these challenges as they apply to engineering educators—those whose responsibility it is to inculcate a feeling of professional pride in engineering students. This is an almost impossible task unless the teachers have a genuine professional feeling themselves—and they show it in their daily lives. Here, example and emulation are a necessity.

Teachers must make sure that students understand the relationship between engineering and science—the fact that engineering is both an *art* and a *science*. Teachers must show that they believe in the American capitalistic free enterprise system under rule of law and not the socialistic system, which stifles both individual initiative and imagination.

Engineering teachers must have knowledge of the *social*, *political*, and *economical* aspects of engineering projects as well as the *technical* aspects. Engineering education must of necessity concentrate upon the basic technical aspects of engineering, but students must be made to understand the importance of the other aspects. Students must understand the importance of ethical action in the practice of engineering—responsibility in those areas that cannot be covered by law. Students must understand the responsibilities of the engineer to the general public.

Here engineering educators have not done a good job. The author calls attention to many current shortcomings of the profession. Why are there these shortcomings? Part of the reason is because there are many engineering educators who have had no direct contact with practice, or their contact has been of such a nature that they have not had to carry any of the responsibilities of practice. Many have lost sight of the fact *that the prime purpose of engineering education is to prepare for the practice of engineering*.

Only those with an understanding of engineering practice can instill in the students a genuine feeling for professional ethics and a pride in their profession. Engineering students must be made to see their responsibilities in educating the general public as to the true nature of engineering.

The professional societies must do all they can to see that engineers are used in executive positions on engineering projects.

All engineers—both those in practice and those in education—must, as the author writes, continually ask themselves: "Am I applying science and technology so it will serve the best interests of the public and of my country in the foreseeable future?" Furthermore, they must not be afraid to express their beliefs to the

[a]April, 1980, by Adolph J. Ackerman (Proc. Paper 15374).

[2]Prof. Emeritus of Structural Engrg., Purdue Univ., Lafayette, Ind.; also Consulting Structural Engr., 312 Highland Dr., West Lafayette, Ind. 47906.

general public and to our legislative bodies. Eternal vigilance is required of all. We owe the author a vote of thanks for bringing these challenges to our attention.

Discussion by W. G. Huber,[3] F. ASCE

The author again has exercised his special talents in drawing upon an impressive professional experience and intensive research to shape his credo. He holds for personal and professional integrity, reasoned dissent, preeminence of the public interest, engineering control of technology, and the ideals of constitutional government, capitalist free enterprise and economic conservatism. This well documented paper is a fitting sequel to his many articles on professional ethics and the problems of nuclear power. Typically his writing is forceful, forthright, and provocative, all quite commendable in striking that balance which is as necessary in society as in statics. Even as he addresses them, the author would probably agree that, as a group, engineers rank at the top in integrity and solid good citizenship but that they are not made to be political activists, except for a few like the author. Generally engineers prefer the nearer certainties of their exacting disciplines to analyses of the endlessly complex social effects of their work. They are, by nature, builders and conservationists with little heart for crusades and quite uncomfortable on white horses.

The current virtual shutdown of the nuclear power industry in this country is perhaps a classic case in accord with the author's ideas, i.e., an informed public acting through democratic processes has achieved an objective conceived to be in its best interests. The author would have engineers lead similar campaigns. Elsewhere in the world the benefits of nuclear generation are deemed to outweigh the risks. We shall hear more of that later. Thanks to communications and education it is possible for seekers everywhere to obtain ample knowledge of the contemporary world and informed dissent in everywhere active. The revolution will continue but "reforms" will have hard going because they always impinge on those fallible humans who have, for so many centuries, defied perfectability. It is always a matter of whose ox is gored and how badly. For example, the highly lethal but much loved private automobile is practically sacrosanct, used even by demonstrators at Seabrook. To paraphrase Pogo and Will Rogers, the problem is us, each and every one, everywhere, all the time.

The author's fears for the survival of our political and economic freedoms and ideals echo those of many others of the past, notably Alexis De Tocqueville who said most of it in 1835. There are deep-running conflicts in the author's stated objectives. Nuclear power and our whole technology are instances of quasi-capitalistic free enterprise which he appears to favor but would also restrict. Enterprise, despite all the rascality and corruption which have accompanied it, has rewarded practitioners and their contemporaries and enriched the thing we call civilization. However, as with all human endeavor, enterprise has never been an unmixed blessing. Thus today every nation in the world is in trouble trying to digest the fruits of 20th century technology. Worldwide mechanization dependent on diminishing resources has led to overproduction of muscle power,

[3]Retired Project Mgr., 2208 Foust St., Marysville, Calif. 95901.

an ever-renewable resource with a voice. The dilemma calls for at least several Solomons. Key ideas are: political power for the strong, jobs and more material wealth for the followers. The author's public, including engineers and politicians, does express itself. Thus a loud accent has been on jobs ever since Adam Smith's theories turned to smoke in the 1930's. Hunger and the trauma of joblessness are powerful incentives. Since then governments have treated the ills of the industrial revolution by better distribution of production and the creation of jobs by monetary inflation. These measures plus the Tennessee Valley Authority (TVA) came in with Franklin Roosevelt and have received most of the votes ever since. Today that public, ever intent on living in the here and now, actually likes inflation and would never for a moment consider doing without their deadly cost-of-living bonuses. Our present surfeit of goods and leisure may be an unhappy reminder of the Roman Empire on the downslope, but it had survived some five centuries and with humanity, a beginning always follows an end.

Since 1945, America has continued deficit spending and given away its technology and natural resources as means of sustaining an economic boom. The result is a chaotic monetary situation at home and abroad with our markets shrinking. To date the people show little will to end such fiscal folly and to support a restoration of our military power. Meanwhile Soviet Russia believes that armies are the key to winning and holding empire, as is borne out by history. Our remaining freedoms are indeed in danger of being lost.

Traditionally, engineers have met the demand for their services by designing structures and machines conforming to the economic dicta of the day; labor-saving but requiring more fuels and materials. Such profligacy has now caught up with us and current publicity may stir the people towards conservation. If some 40% of our energy consumption is wasted and our buildings oversized, then technology and engineers can guide the vast and necessary reform by modifying existing works and designing future works to maximize energy efficiency and minimize the drain on other nonrenewable natural resources. Although such a transition will be excruciatingly painful especially for the large and well-entrenched transportation and construction industries, the welfare of the nation is involved and the hard facts must be brought out and faced.

The author of this excellent paper relating an engineer's experiences within the system, builds his thesis on American men and events of this century. The paper could well have been entitled "Responding to the Challenge of Life" and related to the record of fifty centuries of human societies. That record is the key to a compassionate understanding of the problems cited by the author and shows that only in the realms of technology has any basic change occurred since the heyday of Sumer. The Babylonian camel driver was well versed in the arts of capitalist enterprise and empires survived when they had able leaders and military might. Only through superior technology were Hitler and Stalin in our own time able to outdo Ashurnarsipal and Tamerlane.

The founding fathers wrote our constitution for a republic. Today we are the democracy envisioned by De Toqueville wherein each citizen can vote more largess for himself while tolerating stupidity, fraud and corruption in public and private institutions. The author's urging to improve our moral stance is timely but in collision with the stubborn elemental human instinct to survive. The record shows all Utopian efforts have failed because they required that

the basic nature of humans be changed. Perhaps the ultimate wisdom is recognition that even modern man is not likely to be endowed with the requisite omniscience to achieve that transformation. A large portion of the author's message is condensed for the guidance of engineers in the one interrogatory sentence of his introduction. Bold indeed will be those who venture to answer that question in the affirmative, because the right answer calls for prescience beyond that possessed by any of the sages and prophets who made history before us. The "public" is an agglomeration of infinitely diverse particles which wants to decide for itself what will "best serve its interests," and our knowledge of the "foreseeable future" is limited to what we will learn from the past.

In our hands the social problems of the past are simply compounded by our greater mastery of technology. How dull the world would be without problems, indeed a lack of them would be the worst possible problem. Social ferment creates jobs for social scientists—and engineers. The record says that the people of our world will do many fearsome things in times ahead but will always pull back from the brink. Rather than to propose any philosophy of despair or doomsday, these comments are to emphasize the relevance of a widened horizon and the longer view.

Discussion by Raphael G. Kazmann,[4] F. ASCE

The author has performed a service for the engineering profession in setting forth his views on the ethics and morality involved in engineering practice. The difference between a technology and a profession is the presence of ethics and morality in the latter. A technology requires competence and good, reliable work. Engineering practice requires competence, good reliable work, and a prior decision as to whether the work is beneficial to society in the long run or deleterious—and since the engineer is in responsible charge of the work, the ethical and moral decision is the crux of the matter.

Professionalism means that when a project that you are directing turns out to be unfeasible after careful economic and engineering evaluation, you inform the responsible authority. If the authority decides to go ahead, it is incumbent on you to terminate your connection with the project and make public the reasons for your action.

This country is still trying to recover from the conduct of technicians, instead of professionals, in a sister profession—the military service. When the decision was made to aid South Vietnam in its fight against Soviet imperialism (the North Vietnamese were the Cubans of Asia), the generals gave the President a reasonable estimate of what it would take to do the job. When President Johnson and Robert McNamara decided to escalate the war slowly, and to give the Vietcong privileged sanctuary, there were statements from authoritative military leaders that these actions would lead to disaster. But there were no resignations in protest—once the President had decided, they complied against their professional judgement. That was the event that separated professionals from technicians—and the United States failed to win the war, some 50,000 men lost their lives, 3 million Cambodians have since been murdered by the

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communists, at least half a million residents of South Vietnam have become refugees from the communist prison that was established in the entire area and, not least, the morale of the United States has been impaired. All due to lack of professionalism in the top echelons of the military establishment.

In the profession of civil engineering similar lapses from professionalism are found. The coasts of the Nation, and its lakeshores are filled with marinas that were constructed at public expense and should never have been built. The excuse is that Congress (or the local legislature) appropriated the money and the engineer had no choice but to accomplish the desire of his employer. This is professionally absurd. If a patient demanded that a surgeon remove hemorrhoids when the doctor diagnosed the illness as a kidney ailment, would we believe that the surgeon was fulfilling his professional commitment if he operated as the patient directed and against his better judgement? The surgeon's proper answer would be to refuse to perform the operation and inform the patient of the reasons. If the patient persisted in his demand, the surgeon would have to tell him to look elsewhere. The responsible professional engineer must act in an analogous manner.

Of course it will be pointed out that the engineer could lose his job if he acted that way in discharging his professional obligations. But this is part of the price of being a member of a profession: someone may punish you for performing according to professional standards. In a free, capitalist society, however, there will be many people and organizations who are looking for ethical professional engineers and any period of reduced employment will undoubtedly be short-lived. In socialist countries, where the government controls the livelihood of each and every citizen, the exercise of professional judgement involves personal peril. And yet the jails and psychiatric wards of the Soviet Union (and its vassals) are filled with men whose only crime was to act in accordance with professional judgement and personal integrity.

The principal failures of professional practice in the field of water resources, as the author points out, are primarily associated with Federal or state projects where political considerations overshadow engineering and economics. Once a project is constructed it is considered an engineering achievement even though it is uneconomical and may be short-lived. Existence of the project encourages private individuals to make investments and commitments in the area that would otherwise have been made elsewhere. When, e.g., the reservoir fills with silt and its ability to reduce flood peaks or deliver firm water is decreased, those persons who considered floods to be under control and adequate water to be availability in perpetuity, are victims, not only of political chicanery, but of a lack of professionalism in the practice of civil engineering.

The author points to the abdication of engineering responsibility in the area of electricity generated by nuclear-fueled reactors. The Price-Anderson Act removed liability from those responsible and transferred it to the Nation's taxpayers. Ironically, the known domestic sources of uranium are inadequate to supply the lifetime requirements of reactors now on line plus those now under construction and more than 50% complete. In order to make up for the officially unacknowledged shortfall of fuel, designers are attempting to increase burn-ups of fuel elements some 50%–100% by changes in cladding and other expedients. Moreover, the reserve picture is being changed by others, possibly engineers. They now include as ore, rock with concentrations of U_3O_8 as low

as 100 ppm whereas the average uranium content of ore now being mined is approx 1,100 ppm (31).

Independent studies as far back as 1975 (32,33,34) concluded that the yellowcake reserves were inadequate to support the projected construction program. There has been some talk of replacing uranium oxide with thorium, thus increasing the fuel supply. But, in the writer's opinion, to rely on untried processes for the production of commercial power by public utilities is not only professionally irresponsible, it is stupid.

Fig. 1 shows the writer's estimate of fuel reserves as compared with the 30 yr lifetime requirements of existing plants plus those under construction.

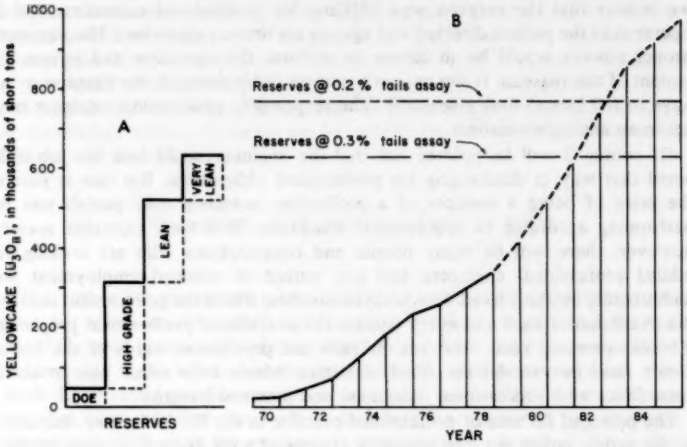

FIG. 1.—(*a*) Available Reserves of Yellowcake Equivalent, in thousands of short tons; (*b*) Lifetime Requirement (30 yr) of Plants now in Operation plus Those Scheduled to go on Line in Year Indicated (Plants in Operation by 1983 Will Require, During Their 30 yr Lifetimes, a Tonnage of Yellowcake in Excess of Our Estimated Reserves)

It is based on official estimates (35) of reserves and known annual refueling demands of light water reactors in the United States.

APPENDIX.—REFERENCES

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Discussion by Phillip Z. Kirpich,[5] F. ASCE

Nearing the end of a career that began 45 yr ago, I want to add my voice to that of the author concerning: (1) The low *integrity quotient* of today's engineers; (2) the inadequate education of *professional* engineers; and (3) the poor quality of papers published by engineering societies.

Ackerman sums up the first of these situations in his Appendix VI wherein he refers to engineers being reduced to "mere technicians and puppets of unscrupulous beaureaucrats." This rings a bell and reminds me of the occasions in my career when I fought such bureaucrats—sometimes successfully but more often not—for which I am proud for having preserved my integrity. I unfortunately agree with Ackerman that, generally speaking, engineers do not stand up and fight for what they inwardly believe to be right.

As far as the second situation is concerned, the profession continues to be struck in a rut, namely, a standard 4-yr curriculum which produces technicians, *not* professionals. Because of the resulting shortage of broad-based professionals trained in the humanities as well as applied science, both society and the engineering profession suffer (36).

I again sadly agree with Ackerman in regards to the third situation; his statistics on the poor quality of papers presented (p. 146) is unfortunately illustrative of a widespread situation. The answer? Peer review should be greatly strengthened.

Appendix.—Reference

36. Kirpich, P. Z., "The Leadership Constraint in Project Preparation," *Issues in Engineering—Journal of Professional Activities*, ASCE, Vol. 102, No. EI4, Proc. Paper 12503, Oct., 1976, pp. 417–422.

Discussion by Alfred Ogram,[6] F. ASCE

My highest compliments to Adolph J. Ackerman for his highly illuminating and well documented paper. In my opinion, his most important accomplishment is the identification of the real culprit which has caused the ethical deterioration in our profession: BIG GOVERNMENT! And, if it is of any solace, the same also currently applies to many other fields: medicine, law (the worst of all), business, in fact, all of American Society.

For a better perspective, let us review history a bit. Our Nation, under a Constitution for individual freedom and a government limited to our protection from aggression, grew in a mere 150 yr from a group of poor subservient colonies

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to the wealthiest, most powerful country on the face of the earth and with the highest standard of living ever known to Man. But the last 54 yr have seen an abrupt change from individual freedom at an accelerating rate down the road towards slavery under a horrendous expansion of government into a behemoth of laws and regulations, all imposed by power-seeking politicians who, with the help of a congenial supreme court, have twisted the interpretation of a few words, such as "welfare," into the antitheses of what was originally intended. Thus have arisen the difficulties of today.

Originally, government was our servant. *We* told it what to do. Today, *we* are the servants of Big Government. It tells *us* what to do, be it ethical or lacking in ethics. The author has given us some excellent examples of our failure and BIG BROTHER'S success. Remember, 1984 is not far away! We have little time to change for the better!

Discussion by C. Ken Weidner,[7] F. ASCE

This paper should strike a very responsive chord in all engineers who have practiced during the past 60 yr in important professional positions. He has clearly defined the progressive self-destruction of the engineering profession and its abdication to Administrative Law and to the Fabian Socialists who sponsor and implement it.

There will be many, no doubt, who will say that his dissertation is based on an isolated experience. But this is not true. I know many whose careers, although all different, involved the same basic experiences. The great tragedy will be that most of those who read this paper will *not* have a full comprehension of what it means. This will be particularly true of those who have entered the profession since the "New Deal" era.

Mr. Ackerman very accurately defines the beginning of the decline and abdication of the profession to the subversion of the original objectives of the Tennessee Valley Authority (TVA). The first Chairman and Chief Engineer was Arthur E. Morgan, Hon. M. ASCE, a forthright unsubvertible professional engineer. He created the competent organization of civil engineers who designed and built the great hydroelectric, flood control and navigation structures which stand as permanent monuments to his engineering vision, capacity and philosophy.

However, in the matter of maintaining sound ~~economic~~ and political policies under the Rule of Law, along with financial responsibility, he lost the battle to the New Deal socialists and was replaced by a Fabian socialist bureaucrat. (Unfortunately, the advent of World War II largely obscured the importance of this far-reaching event.)

At the end of the war and the termination of the Manhattan Project which had produced the "A" bomb and launched the new atomic age, Congress decided that all atomic development in this country should be controlled by a new governmental agency, the Atomic Energy Commission (AEC). Since the thinking in government circles continued to follow the socialist ideology of the New

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Deal, this commission was tailored after the TVA socialist pattern. Furthermore, the man who had replaced Arthur Morgan and was then the guiding subversive influence in TVAs policies and ideology was appointed Chairman of the new AEC.

I witnessed all this at first hand as the Chief Engineer in charge of the design and construction of the new Argonne National Laboratory which the University of Chicago built for the AEC as the first nuclear research center for peaceful purposes. I was exposed to all the machinations which are part and parcel of the Fabian socialist method of gradually placing everything professional under bureaucratic socialistic control.

However, with the support of the University and some members of the Joint Committee of Congress, we completed the project without loss of professional control. But when a supplemental phase was authorized, the AEC implemented it in accordance with its established procedures. The engineers in charge were actually technical employees of the bureaucracy with no professional responsibility or accountability.

During the war almost all of industry became beholden to the Federal government for orders. The government methods of supervising these contracts wrought a permanent change in the concepts of industrial management in this country. The committee management concept was born and became permanent. This concept eliminated the traditional title and authoritative stature of the "Chief Engineer," along with his individualized responsibility. Therefore, by the end of the war most industry had become as bureaucratic as the government. It was during the early postwar period that much of the best engineering talent was released from the armed services and found its way back into civilian life. And it was during this time that the largest shift in orientation came about in the profession.

Unfortunately, most of those in control of the professional societies at the time seemed disposed to ignore the situation, and those of us who raised the issue were judged out-of-order. For many years the voice of dissent was definitely taboo. The author has identified this period in his cited paper "Slow Death of a Free Profession," (5) but further review is needed of the mismanagement and disorientation of the engineering societies during this period.

Breakdown in Engineering Education.—During the past 40 yr the character of our socalled engineering faculties has also changed basically. Where professional experience once was the first criterion for qualification to teach engineering, the Ph.D. in some specialized technology has become the open sesame to a faculty position. The bulk of our faculties today is made up of those who progressed academically through the degrees to a Ph.D. in some specialized technology without ever being exposed to the real world of practice. Few are qualified to teach anything outside the specialty of their doctoral dissertation. Fewer yet are qualified to teach anything based on responsible experience in practice. How, then, can any of them be expected to transmit to students any concept of actual practice? As a result ethical responsibility has gone by the wayside along with intellectual honesty in a professional sense.

I learned this at first hand when, at the completion of the Argonne Project, I was invited to go to the American University of Beirut, Lebanon, and establish a School of Professional Engineering and Architecture. We were required by the governments of the countries from which we accepted students to certify

that our graduates were eligible for a license to practice. This required that all the faculty engaged in teaching engineering subjects be licensed practicing engineers. The science, technology, and cultural courses were taught by specialists in those fields. It required a 6-yr course for the professional degree. The program was highly successful. However, only one American professor was effective. The primary cause of American faculty failure was their concept of engineering as a profession and their philosophy of teaching it.

The Road to America's Suicide.—Any serious study of the basic forms of socialism, [i.e., (1) Communism (the control of the State and all in it by a dictatorship of the proletariat), (2) Fabian Socialism (the gradual bureaucratic control of those who produce to support all of those who do not produce), and (3) Syndicalism (the control of industry and government by organized labor)], and the counterpart of socialism, those Fascists' ideologies of the far right which produce the same social and economic results lead one to the inevitable conclusion that for any or all of these to succeed in the United States, the engineering profession MUST first be subverted!

What Mr. Ackerman has actually done is outline, for all to see, how far these subversive socialist forces have progressed in their efforts to have this most important profession commit suicide!

To everyone who is seriously concerned about the health and future position of the engineering profession and the Republic, Ackerman's paper is a most timely exposé of the profession's present hazy regard for its responsibility to the public and the Country that it exists to serve.

There is little that can be added to his presentation of the results of our collective neglect of our basic justification for existence as a learned public-service profession. Many reasons have been offered for the progressive neglect of the profession's responsibility to the public for its protection and safety. However, there is no adequate, genuine excuse for it.

It is of little value to claim that this neglect has come about as a result of the Federal government or other segments of our social structure having usurped the basic right and obligation of the profession. If the leaders in our professional societies had consistently and publicly opposed the efforts of the various socialist forces to take over the United States, it could not have happened.

It is clear that if the engineering profession is to survive it must reassert itself and re-establish its position as the guardian of public safety and development in the minds of the public, the government, and, above all, the profession itself.

From the time of its founding until its progressive abdication, the engineering profession constituted one of the strongest and most influential blocs of people in our society. Unfortunately, this is no longer true. The impact we now have as a profession on national policy and evolving economy is practically nil. To all intents and purposes we have ceased to be the professional guardians of our society, but have become, instead, a collection of specialized technical employees and expert advisers seeking individual security without professional responsibility.

It does not seem to be generally understood by either the public or the profession at large that it is impossible for any engineer to act in a professional manner if someone who bears no professional responsibility has the authority to inhibit, modify or reverse that engineer's professional actions or decisions, or both.

This lack of comprehension of the very basis of professional engineering practice has permitted the progressive substitution of Bureaucratic Administrative Law for the rule of genuine legal and financially responsible practice. That the engineering societies have permitted this lack of comprehension to develop, is to me, the heart of the message of Mr. Ackerman's paper.

The professional discipline of the engineer, applied with moral courage, intellectual honesty, and social responsibility with complete professional freedom, is the only protection which a free society has to insure that the products of science and technology are used in its interest and welfare—and not for its enslavement. It is the prime function of the professional engineering societies to rigorously protect and enforce this concept.

Mr. Ackerman is deserving of the thanks of the entire profession for so ably confronting it with such a timely assessment of the results of its neglect of its own basic responsibility to the public.

Discussion by Harry Wiersema,[8] F. ASCE

From his half century of engineering practice, the author has chosen three examples of challenges in his experience to illustrate his philosophy of the correct response to these challenges. The writer agrees thoroughly with him on two of them, the California Water project and the nuclear power industry, but takes exception to his analysis of the controversy between Arthur E. Morgan, Chairman, and David E. Lilienthal, member of the first board of the Tennessee Valley Authority. Both of us acted as assistants to Dr. Morgan during this period, both took his side of the controversy of more than 3 yr, but each has different opinions as to the fundamental cause of the dispute.

The challenge to engineers on the California Water Project was very well presented in the January, 1973 *Engineering Issues*, not by engineers but by two attorneys; but the writer responded to both papers by a discussion in the October issue. Also the role of the engineer in nuclear power was the subject of a paper by Arthur Fox, then President of ASCE, in the July, 1976, *Issues in Engineering*; and critical discussions of this paper came out in the January and April 1977 issues by the author and the writer, respectively.

It is only in our opinions of the reasons for the challenge of the Morgan episode that we differ. Quoting the author, "various events led to the collision between two political systems, the American capitalistic free enterprise system under Rule of Law, under financially sound disciplines on the one hand, and the socialistic system on the other, as it has been created under "Administrative Law." In the opinion of the writer, the collision was not between two political systems but between two personalities, one the highly idealistic engineer, with ethics ahead of his time, the other a lawyer, trained in practical solutions and with pragmatic principles.

One example of this clash in idealism is the Berry marble case, when Lilienthal wanted to settle a large damage claim with a fairly moderate compromise payment. But Morgan echoed the American position in the Tripoli pirate case—millions

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for defense but not one cent for tribute. Another instance was his position with regard to open disclosure of information, even when it might have led to the advantage of the power companies who were sueing TVA at the time.

When the friction between the two men reached the point where administration suffered, Morgan was faced with a challenge which could have been met in several ways. He could have agreed to a compromise; I was convinced that with some give and take, these two men could somehow work together. He could have resigned, which his wife Lucy strongly advised him to do. But neither choice fitted his personality and he chose instead to fight it out with President Roosevelt, a losing battle. While he did succeed in getting a congressional committee to investigate TVA, this did not achieve his purpose, since the committee divided on political lines, four republicans for and six democrats against him.

When Morgan was deposed by the President the author and myself were both faced with same challenge. He decided to resign from TVA—I decided to remain. My loyalty to the TVA organization, of which I was extremely proud, exceeded my sense of ultimate loyalty to the individual. Arthur Morgan never criticized me for this decision, and I remained his close friend for life, often assisting him in the writing of his books, especially in the one, *The Making of T.V.A.*

Reviewing the many challenges of my engineering career, I feel that most of my decisions were correct, but there is one I will always regret. As a young bridge engineer, I gave in to the pressure of the highway commissioner to sacrifice safety for economy, resulting in a highway death in the first year of operation. This could not happen today. I am not nearly as pessimistic as the author as to the performance of civil engineers in meeting challenges—I think more and more of them are meeting them in the right way. The author has performed a great service to the profession in presenting the pros and cons of a subject of great inportance, and is to be commended on his thorough treatment of the subject and in the way he met his personal challenges.

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